THE EFFECT OF TROPICAL SUNLIGHT ON THE DEVELOPMENT OF BONES OF CHILDREN IN PUERTO RICO

A Roentgenographic and Clinical Study of Infants
and Young Children with Special Reference to
Rickets and Related Factors

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LETTER OF TRANSMITTAL

UNITED STATES DEPARTMENT OF LABOR,
CHILDREN'S BUREAU,
Washington, May 31, 1933.

MADAM: Herewith is transmitted a bulletin entitled, The Effect of Tropical Sunlight on the Development of Bones of Children in Puerto Rico.

The investigation upon which this report was based was planned and carried out under the direct supervision of Dr. Martha M. Eliot, director of the child-hygiene division of the Children's Bureau, who is also the author of the report. The medical examinations were made with the assistance of Dr. Edith B. Jackson. The study of economic and social factors was made by staff members of the Bureau experienced in social investigation.

The Bureau is indebted to the staff members of the Department of Health of Puerto Rico and of the Presbyterian Hospital in San Juan, of the Hospital Asilo des Damas in Ponce, and of the School of Tropical Medicine, University of Puerto Rico, in San Juan. Their interest and cooperation made the investigation possible.

Thanks are especially due to Dr. E. A. Park, of the Johns Hopkins University School of Medicine, formerly of the Yale University School of Medicine, for his assistance and interest in the planning of the investigation and the interpretation of the results.

Respectfully submitted.

GRACE ABBOTT, *Chief.*

Hon. FRANCES PERKINS,
Secretary of Labor.

THE EFFECT OF TROPICAL SUNLIGHT ON THE DEVELOPMENT OF BONES OF CHILDREN IN PUERTO RICO

A Roentgenographic and Clinical Study of Infants and Young Children with Special Reference to Rickets and Related Factors

PURPOSE OF INVESTIGATION

The study of Puerto Rican children here reported was undertaken in order to observe the roentgenographic appearance of the bones of infants living under the influence of tropical sunlight and to make comparisons between the roentgenographic appearance of the bones of such infants and that of the bones of infants living in a temperate climate. During a previous investigation made in New Haven, Conn., by the Children's Bureau in cooperation with the department of pediatrics, Yale University School of Medicine, it had been found that the bones of a large proportion of infants living in this temperate climate showed sooner or later by roentgenographic examination certain minor changes that were interpreted as evidence of slight rickets. Because such a large proportion of infants in New Haven showed these slight changes, regardless of the fact that they had been given what was thought to be an amount of cod-liver oil sufficient to prevent rickets, the question had arisen whether the changes should not be regarded as physiological variations of normally growing bone rather than as the evidences of beginning rickets.[1]

Questions had arisen also in New Haven as to the correct interpretation of certain skeletal signs used in the clinical diagnosis of mild rickets. Study of a group of infants and young children who had lived continuously in a tropical climate, exposed the year around to intense sunlight, would, it was hoped, answer a number of these questions.

Though it was assumed, when Puerto Rico was selected for the investigation, that the intensity of the sunlight there and the possibilities of exposure were such as to insure the prevention of rickets and allow for normal growth of bone, it was nevertheless essential to the main purpose of the study that this assumption be confirmed before the data collected in Puerto Rico could be used with certainty as a normal control for the data collected in New Haven. In this report, then, the incidence of rickets (unquestioned) in Puerto Rico and also of those minor deviations from the normal commonly interpreted in the New Haven study as evidence of slighter degrees of the disease will be discussed as a basis for conclusions regarding the roentgenographic appearance of the bones of normal infants. From time to

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[1] Eliot, Martha M.: The Control of Rickets; preliminary discussion of the demonstration in New Haven. Journal of the American Medical Association, vol. 85, no. 9 (Aug. 29, 1925), pp. 656-663.

time, also, comparison will be made between these Puerto Rican children and an unselected group of New Haven children who, during the previous study, had been examined by the same physicians and whose mothers had had no specific advice with regard to the prevention of rickets.

The investigation was made in the two principal cities of the island, San Juan and Ponce, because of the facilities in these two places for making roentgenographic examinations and for observing a large number of infants within a short period of time. During a period of six weeks (from the last week of January, 1927, to the second week of March) 584 children were examined, and the homes of 556 of these children were visited in order to obtain information regarding diet and living conditions, especially exposure to sunlight.

In the course of the investigation the examinations of the Puerto Rican children and the visits to their homes brought out so many other findings of interest in connection with the health of these children that it seemed desirable that the report should deal with other aspects of health besides those relating to the presence or absence of rickets. Indeed, the interpretation of the roentgenographic and clinical findings with regard to rickets is itself so dependent on an understanding of the growth and development of children that a discussion of the general health of children in the island and the conditions under which they live is given before the discussion of the special examinations for rickets.

GENERAL CONDITIONS AFFECTING HEALTH OF YOUNG CHILDREN IN PUERTO RICO

The health of young children in any community depends to some extent on underlying racial and climatic factors; to a larger extent on the general health conditions prevailing in the community, including the facilities for health education and medical care; and to an even larger extent on the economic and social status of the community as a whole. The health of the children in Puerto Rico is no exception to this general rule. Intermixing of races, a tropical climate, ignorance, poverty, overpopulation, irregularity of employment, probably all contribute to the high incidence of malnutrition as well as to the high incidence of disease and death. A report on the health of the children studied in the present investigation would be incomplete without some picture of these underlying factors. A detailed discussion of certain social and economic factors such as income, housing, family grouping, and diet will be given in later sections. (See pp. 61–97.) As a background for the more detailed discussion a general discussion of climatic, racial, and economic factors, as well as of the general health conditions, is given in the following sections.

CLIMATE AND SUNLIGHT

The island of Puerto Rico, the fourth largest of the islands of the West Indies, lies between the eighteenth and nineteenth parallels of latitude north of the equator, about 5° south of the Tropic of Cancer. It is located, therefore, well within the Tropics.

The temperature [2] varies comparatively little from season to season, averaging 75° to 76° F. in the winter months and 80° to 81° F. in the hottest summer months. Throughout the year the sunlight is intense, and even in the so-called winter months it is so hot at noon that in order to avoid the great heat and bright light the people remain, if possible, indoors or in the shade. The windows of the houses or huts do not have glass, but many have wooden shutters to keep out heavy rain and intense sunshine.

Though the island is comparatively small—a little more than 100 miles long from east to west and about 40 miles wide—it has several varieties of climate. Heavy tropical showers are frequent in the northern part of the island and comparatively infrequent in the southern. The sunlight is even more continuous in the south than in the north and for long periods of time is unrelieved by cloud or shower. The city of Ponce, situated on the southern coast of the island, has less rain and more sunlight than has the city of San Juan, on the northern coast.

Because of the well-recognized association between normal calcification of bone and adequate exposure to sunlight, it is obviously of importance in any community where the growth of bone or the

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incidence of rickets is being studied to consider the amount of sunlight to which children, especially young infants, are ordinarily exposed.

HOURS OF SUNLIGHT

The following comparison shows the daily average of possible hours and of actual hours of sunlight during each month in the year for San Juan, P. R., and for New Haven, Conn. It also shows the total number of possible and actual hours of sunlight a year in both San Juan and New Haven, and the daily averages for the year.[3]

Month	Daily average of possible hours of sunlight		Daily average of actual hours of sunlight	
	San Juan	New Haven	San Juan	New Haven
January	11. 2	9. 6	6. 9	4. 7
February	11. 6	10. 6	7. 8	6. 4
March	12. 0	12. 0	8. 2	7. 1
April	12. 6	13. 3	7. 8	7. 5
May	13. 0	14. 5	7. 6	8. 4
June	13. 2	15. 1	7. 7	9. 2
July	13. 1	14. 8	8. 1	9. 2
August	12. 7	13. 8	8. 4	8. 4
September	12. 2	12. 5	7. 4	7. 7
October	11. 7	11. 1	7. 3	6. 6
November	11. 3	9. 9	6. 9	5. 3
December	11. 1	9. 3	6. 8	4. 9
Total for year	4, 416	4, 456	2, 774	2, 592
Daily average for year	12. 1	12. 2	7. 6	7. 1

Although the daily average of possible hours of sunlight is about the same in the two cities, the average of actual hours is somewhat greater in San Juan. Much less seasonal variation occurs in San Juan, however, in both possible and actual hours of sunlight than in New Haven. In San Juan, moreover, the uniformly warm climate allows the actual hours of sunlight to be continuously available throughout the year to children living there, whereas in New Haven the long cold season occurs coincidentally with the decrease in actual hours of sunlight and limits still further the availability of what sunlight there is. Though during the summer months the daily average of actual hours of sunlight in New Haven exceeds that in Puerto Rico, this period is short and does not bring the total number of actual hours of sunlight a year up to the number available to children in Puerto Rico.

INTENSITY OF SUNLIGHT

In addition to the advantage that Puerto Rico has over New Haven in actual hours of sunlight, it has the advantage also in intensity of sunlight. Though accurate measurements are not available, it is probable that at the latitude of Puerto Rico (about 18° N.) the intensity of the sunlight is relatively high and that it varies little from month to month, whereas at the latitude of New Haven (about 41° N.) without much doubt the intensity is lowered during the winter months. Tis-

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[3] Figures supplied by Weather Bureau, U. S. Department of Agriculture. Averages of actual hours are based on a 25-year period for San Juan and on a 20-year period for New Haven.

dall and Brown,[4] who studied the relation of the altitude of the sun to its antirachitic effect, regard 35° as the altitude below which there is definite decrease in the ultra-violet content of the sunlight. They state that in Jamaica, which is at about the same latitude as Puerto Rico, the minimum altitude of the sun for the year is 50°, whereas in Boston, which is at about the same latitude as New Haven, it is below 35° for four months of the year. When the uniformly high temperature of Puerto Rico is taken into consideration there is little doubt that the possibility of long daily exposure to sunlight, which is effective in the prevention of rickets, is very great for infants in San Juan—far greater than for infants in New Haven.

EXPOSURE TO SUNLIGHT

Out of the equable climate of Puerto Rico have grown customs and habits of living which insure an out-of-door life for children as well as adults. The construction of the houses, the type of clothing, the customs with regard to housework, all make exposure to sunlight inevitable.

In Puerto Rico it is customary to keep babies indoors for the first 40 days of life, but because of the absence of window glass and the almost universal accessibility of sunlight inside the houses (see pp. 70–75), it is probable that even these youngest babies receive some direct sunlight, though apparently no conscious effort is made to insure their getting any. After this early period the amount of exposure to sunlight increases rapidly, since it is then considered safe to take the baby out. Baby carriages are not used in Puerto Rico except by the well-to-do, and it seemed to be the universal custom for the mother to take the baby outdoors in her arms, or, when he was older, astride her hip, supported by her arm or by a sling hung from her neck. The mother usually took the baby with her when she did her daily errands, held him in her lap as she sat in the sun, or let him sit in a box used as a makeshift play pen while she worked in the patio or yard. A few mothers made special efforts to protect their young babies (usually those with the fairest skins) from exposure to the sun in order to prevent tanning, but most of these mothers admitted that they were not successful in keeping the baby out of the sun all the time. As soon as a baby learned to creep or to walk, he would begin to get more sunlight. Again and again a baby would be seen playing in an open sunny doorway, or hanging over a bar placed across the door to keep him from falling down the steps, or playing about the patio where his mother could watch him while she worked.

After a baby has learned to walk exposure to sunlight is almost inevitable, as his playground is the yard, the patio, or the street, all of which are sunny most of the time.

The fact that little children in Puerto Rico need no clothing to protect them from cold makes it possible for them to get plenty of direct sunlight. During the early months of the baby's life one or two garments are customarily put on him, but many a child 6 months or a year old was seen playing about the house or in the patio without clothes, or wearing but one scanty garment such as a shirt or short dress. Even children 2 or 3 years of age wore little or no clothing.

[4] Tisdall, Frederick F., and Alan Brown: Relation of the Altitude of the Sun to Its Antirachitic Effect. Journal of the American Medical Association, vol. 92, no. 11 (Mar. 16, 1929), pp. 860–864.

DENSITY OF POPULATION

The population of Puerto Rico is very dense, the territory being fifth in order of density of all the States, Territories, and possessions of the United States; only the District of Columbia, Rhode Island, New Jersey, and Massachusetts have denser populations.[5] In 1930 the population of Puerto Rico was 1,543,913. Of these persons 1,116,692 (72 per cent) lived in the rural parts of the island; the remaining 427,221 (28 per cent) lived in the 40 cities and towns of more than 2,500 population: 114,715 in San Juan, 53,430 in Ponce, and 259,076 in the other 38 cities and towns.[6] The wide distribution of the people throughout the hills and coastal plains with consequent isolation is responsible for many of the health problems that are most difficult to solve.

RACE

That the Puerto Ricans are a mixture of highly pigmented peoples, being partly Indian, partly Negro, and partly Spanish, is of interest in this study in view of the well-known high incidence of the severer degrees of rickets among the children of highly pigmented peoples living in temperate climates. In the early sixteenth century, at the time of the settlement of Puerto Rico by Spaniards, the island was inhabited by Indians. During the years of settlement the number of full-blooded Indians was greatly reduced by slavery, war, epidemics, and intermarriage, until, according to the early Spanish records, the Indians as a distinct race had disappeared 50 years after the coming of the Spaniards. During these years there was undoubtedly a mixture of Indian and Spanish blood, but it is difficult to determine how much Indian blood still exists in the island. Boas[7] calculates on theoretic grounds that possibly 14 per cent of the natives of the island have Indian blood in their veins and thinks that the amount of Indian blood in the rural districts is greater than is ordinarily assumed. Early in the period of settlement the first African negroes were brought to Puerto Rico as slaves; from then on the number of negroes in the island increased gradually. After the first importation of slaves a mixing of the two races began, which has continued down to the present day. The result is that in Puerto Rico to-day is found a race of people, who, though predominantly Spanish in type, show many evidences of negro blood and, in districts where less mixture with the negroes has taken place, show some remaining evidences of Indian blood.

How much influence this mixing of races has had upon the growth and stamina of the people can not be estimated. The apparent retardation in the physical growth and development of the children is probably a result not only of this mixture of races but also of various environmental factors.

ECONOMIC CONDITIONS AND DIET

The economic condition of the great majority of the native Puerto Ricans is extremely poor, and this fact unquestionably plays a major rôle in the generally poor physical condition of the people, and of the children in particular, as will be shown later. (See p. 61.) A large

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[5] Fifteenth Census of the United States, 1930, vol. 1, Population.
[6] Ibid, pp. 1251, 1263.
[7] Boas, Franz: The Anthropometry of Puerto Rico. American Journal of Physical Anthropology, vol. 3, No. 2 (April–June, 1920), pp. 247–253.

proportion of the men are employed in the various agricultural pursuits of the island, but they own no land and move about from plantation to plantation as the various crops need planting or harvesting. Wages for such work are very low, and the supply of laborers is very large. The standard of living, at the same time, is so low that it is possible for a family to exist on an unbelievably small income. In the rural districts the farm laborer usually lives in a hut on the plantation where he works. He may or may not be allowed to cultivate a small piece of land about his hut. If he does have the opportunity, he may raise a few banana trees or have a small truck garden. The fact, however, that these farm laborers do not own the land on which they build their houses and that they move frequently from plantation to plantation with the rotation of crops prevents them from having either the desire or the time to cultivate the land around their huts to any extent.

The economic situation is such that many families do not have common necessities, such as an adequate diet and a house equipped with beds, chairs, tables, cookstove, cooking utensils, and proper sanitary arrangements. Living is, on the whole, so simple that it requires little effort. There is no heating problem, the children need little or no clothing, and the adults need only enough to cover them; few persons in the rural districts wear shoes. A few cents a day suffices to provide the rice and beans that are the basis of the diet. The wide scattering of the rural population through the hills of the island makes the distribution of perishable foods difficult. Milk, eggs, and fresh meat are not available to the majority of people in the rural districts. In the cities the conditions are little better, for wages are low, and though milk, eggs, and meat are more easily obtained there, these foods are comparatively little used because of their high price.

The poverty of the Puerto Ricans affects the health of the children primarily through the resulting inadequacy of their diet, especially with respect to milk. The importance of milk as an indispensable part of the diet of all growing children and of pregnant and lactating mothers is well recognized everywhere to-day, but in Puerto Rico not nearly enough milk is either produced or imported to supply the needs of the children or of the mothers. The United States Census of 1920 reported only 50,311 dairy cows in Puerto Rico, or 1 cow for every 26 persons of the total population. At the time of that census there were in the United States 19,675,297 dairy cows, or 1 for every 5.37 persons. In Puerto Rico at that time the total production of milk was estimated to be 7,613,071 gallons, or 2 ounces per person daily; in continental United States during the same year the total production of milk was estimated to be 7,805,143,792 gallons, or 26 ounces per capita daily.[8]

It is difficult to estimate what proportion of the milk produced in Puerto Rico is actually consumed by the people. From data reported to the commissioner of health of the island it is estimated that the consumption of milk by the total population in the fiscal year 1925–26 was approximately 1 ounce per capita daily and that in 1926–27 it was less than 1 ounce per capita daily.[9] Undoubtedly some milk, both cow's milk and goat's milk, was consumed in the rural districts that was not sold and was therefore not reported to the commissioner of health; but this amount probably was small.

[8] Fourteenth Census of the United States, 1920, vol. 5, Agriculture, pp. 28, 654; vol. 6, pt. 3, Agriculture, pp. 383, 388.
[9] Report of the Commissioner of Health of Puerto Rico for the Fiscal Year 1926, p. 83; 1927, p. 113. San Juan.

The importation of canned milk, butter, and cheese from the United States and other countries in 1926 [10] added but little to the total supply of milk and milk products used by the Puerto Ricans.

When all forms of milk are considered, it is probable that the actual consumption of milk and milk products in 1926 was less than 2 ounces of milk per capita daily. It is estimated that in the United States the consumption of milk alone in 1925 amounted to 19.2 ounces per capita daily and that in addition there were consumed per capita annually 17.4 pounds of butter, 4.3 pounds of cheese, 14.87 pounds of condensed and evaporated milk, and 2.8 gallons of ice cream. [11]

The need for more milk in the diet of the Puerto Rican children and mothers, as well as other needs of the families, will be discussed in more detail in the section on social and economic conditions in Puerto Rico (p. 61). The importance of the economic needs of the Puerto Rican people in the problem of child health can not be overemphasized.

INDEXES OF CHILD HEALTH

The best available indexes of the health of a community are the relation of birth rates to death rates, the incidence of communicable diseases, and the mortality rates from certain causes for special age periods. The health of the children in a community is especially reflected in the trend of infant mortality, in the incidence of communicable diseases and nutritional diseases, and in the mortality from such diseases as gastroenteritis and tuberculosis. Since, however, nutritional diseases and general malnutrition are not reportable to health authorities, the extent of these conditions is rarely known on a community-wide basis. Where nutritional disturbances are widespread and medical care inadequate, as in Puerto Rico, study of vital statistics gives an inadequate estimate of the true health conditions. In Puerto Rico, moreover, reporting of vital statistics is very incomplete, [12] and the information that can be assembled from a study of these statistics can be regarded only as roughly indicative of the health conditions in the island.

INFANT MORTALITY

That the infant mortality rate in a community varies with social and economic factors such as the father's earnings, the family's per capita income, the mother's employment, housing congestion, and feeding has been demonstrated by the Children's Bureau. [13] The high infant mortality rate reported in Puerto Rico probably reflects (besides incomplete registration of births) the poverty of the people,

[10] During the fiscal year ended June 30, 1926, 3,743,803 pounds of canned milk (about 2½ pounds per capita), 4,665,931 pounds of cheese, and 789,448 pounds of butter were imported, according to the records of the customs offices of Puerto Rico. Twenty-sixth Annual Report of the Governor of Puerto Rico, pp. 19, 22. San Juan.

[11] A Handbook of Dairy Statistics, by T. R. Pirtle. U. S. Department of Agriculture. Washington, 1928.

[12] In December, 1929, birth registration was only 55 per cent complete, according to the Report of the Commissioner of Health of Puerto Rico for the Fiscal Year 1930, p. 8 (San Juan). From October, 1930, to February, 1931, the United States Bureau of the Census made tests of the completeness of birth and death registration in Puerto Rico to determine whether the island was eligible for admission to the United States birth and death registration areas. Birth registration was soon found to be extremely poor, and the birth-registration tests were discontinued. The death-registration tests showed that 90 per cent or more of the deaths were registered (the percentage of completeness required for admission to the death-registration area). The island authorities took the requisite administrative steps to gain admission, and Puerto Rico was admitted to the death-registration area as of 1932.

[13] Causal Factors in Infant Mortality, by Robert Morse Woodbury. U. S. Children's Bureau Publication No. 142. Washington, 1925.

their illiteracy, their ignorance in matters of child health, and the prevalence of disease in the island.

On account of incomplete birth registration infant mortality rates in Puerto Rico are probably far from accurate. The rates are given, however, to indicate the general trend, as follows:

Fiscal year	Deaths of infants under 1 year per 1,000 live births [14]	Fiscal year	Deaths of infants under 1 year per 1,000 live births [14]
1919–20	146	1925–26	150
1920–21	162	1926–27	167
1921–22	152	1927–28	146
1922–23	143	1928–29	[15]179
1923–24	128	1929–30	133
1924–25	148		

The infant mortality from gastrointestinal diseases is perhaps an even better index of the unfavorable social and economic conditions affecting the health of young children than the infant mortality as a whole, since infant deaths from these diseases are known to result in even larger measure from poverty and from ignorance of methods of proper feeding and care. In Puerto Rico the mortality rate from diarrhea and enteritis for children under 1 year was 41.2 deaths per 1,000 live births in the fiscal year 1924–25, 45.1 in 1925–26, and 55.8 in 1926–27.[16] The incompleteness of birth registration affects these rates as it does the total rate. Though the situation in Puerto Rico is not comparable with that in the United States, it is of interest to note that the rate from diarrhea and enteritis in the United States birth-registration area for the calendar year 1925 was 11.2 deaths per 1,000 live births, for 1926 it was 9.7, and for 1927 it was 7.8.[17]

COMMUNICABLE DISEASES

The communicable diseases that constitute the greatest menace to the health of the people of Puerto Rico are hookworm, malaria, tuberculosis, and syphilis. The actual incidence of these diseases in the island can not be stated with any degree of accuracy. Because of the inadequacy of medical care and of facilities for diagnosis and treatment in the rural districts, the reporting of disease is far from complete. In 1926 there was 1 physician for every 4,500 persons in Puerto Rico; but as nearly half the physicians in the island were in San Juan and Ponce, the rural population had only 1 physician for every 6,800 persons.[18]

Some of the physicians have very wide areas to cover; and since it is often impossible for them to see sick persons before they die, they can only guess the cause of death. Moreover, there are undoubtedly many persons with communicable diseases who are never seen by a physician.

Hookworm disease.

For a long time hookworm disease has infected the people of Puerto Rico, stunting the children and incapacitating the adults. That

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[14] Report of the Commissioner of Health of Puerto Rico for the Fiscal Year 1925, p. 121; 1927, p. 133; 1930, p. 29. San Juan.

[15] The hurricane of 1928 directly or indirectly caused many deaths, which are reflected in the increased infant mortality rate.

[16] Report of the Commissioner of Health of Puerto Rico for the Fiscal Year 1925 (p. 100 and Appendix Table, not numbered); 1926 (p. 101 and Appendix Table 25); and 1927 (p. 131 and Appendix Table 26). San Juan.

[17] Birth, Stillbirth, and Infant Mortality Statistics. U. S. Bureau of the Census, 1925, pp. 2 and 195; 1926, pp. 7 and 200; and 1927, pp. 2 and 194. Washington.

[18] Report of the Commissioner of Health of Puerto Rico for the Fiscal Year 1926, p. 99. San Juan.

hookworm disease was prevalent in 1926 and 1927 is shown by the very large number of cases that were found wherever special investigation was made. Of the 67,727 rural inhabitants who were examined in 1926 the proportion found to be infected was 85 per cent; of 86,029 examined in 1927 the proportion infected was 67 per cent.[19] The proportion of infected persons living in the large cities, such as San Juan and Ponce, was not reported, but it is believed that at the time of the study 50 per cent of the people in the small towns were infected.[20] Intensive work is being carried on by the bureau of rural sanitation of the insular department of health to eradicate the disease, and each year the effect of the treatments given and of the education of the people in modern methods of sanitation and in prevention of the disease is becoming more widespread throughout the island.

The incidence of hookworm disease in the group of children included in this study is not known because appropriate laboratory tests could not be undertaken. As the group was primarily an urban one and as a large proportion of the children were little exposed to the disease because they were too young to walk, it is probable that the incidence was not high.

Malaria.

Malaria was reported most frequently from the lower lands of the coastal plain, especially in the regions of the sugar plantations, where irrigation is extensive. Since malaria is not as a rule fatal, mortality statistics give little idea of the prevalence of the disease or of the economic waste that results from it. The incidence of the disease varies greatly even within a single municipality, depending on the nearness of the dwellings to the irrigated districts. The proportion of infected persons in the lowland districts has been found to vary from 25 per cent to as high as 75 per cent in certain small colonies.[21] The economic loss due to incapacity for work during an attack of malaria is great. In the malaria districts many children were infected; in Fajardo, a town on the east coast of the island, 45 per cent [22] of the cases treated by the department of health in 1926 occurred in children under 15 years of age. No attempt was made to determine the incidence of malaria in the group of children included in this study, since blood examinations were not possible. As, however, only 6 per cent of the group were found to have enlarged spleens, it is probable that the incidence of malaria was not high.

Tuberculosis.

The incidence of tuberculosis was reported from all but two of the municipalities during the fiscal year 1926–27, the largest number of cases being reported from the large cities and towns where special diagnostic and therapeutic clinics were held. The tuberculosis death rates were very high, and it is probable that if the causes of death had been reported accurately they would have been still higher. It has been estimated [23] that the number of deaths from tuberculosis in Puerto Rico is twice as great as is actually reported. In 1926–27 the reported rate of deaths from tuberculosis for the island as a whole was 267 for every 100,000 population, whereas in the cities of San Juan and

[19] Report of the Commissioner of Health of Puerto Rico for the Fiscal Year 1926, p. 41; 1927, p. 61. San Juan.

[20] Ibid., 1925, p. 33.

[21] Report of the Commissioner of Health of Puerto Rico for the Fiscal Year 1925, pp. 77–84. San Juan.

[22] Ibid., 1926, p. 53.

[23] Personal communication (Feb. 1, 1930) from Dr. G. S. Pesquera, who, under the auspices of the National Tuberculosis Association, has studied the morbidity and mortality from tuberculosis in Puerto Rico.

Ponce it was 455 and 389, respectively.[24] The maximum rate of 662 deaths for every 100,000 population for this same year was reported from the city of Río Piedras,[24] where an active campaign for the control of tuberculosis had been begun. It should be remembered that at the time of the study death registration in Puerto Rico was inaccurate.

The rates of death from tuberculosis for Puerto Rico for the fiscal years 1923–24 to 1929–30 and the rates for the United States death-registration area for the corresponding periods show striking differences. The tuberculosis death rates for every 100,000 population were:

Puerto Rico (fiscal years) [25]		U. S. death-registration area (calendar years) [26]	
1923–24	205	1923	94
1924–25	221	1924	90
1925–26	240	1925	87
1926–27	267	1926	87
1927–28	237	1927	81
1928–29	[27] 301	1928	79
1929–30	283	1929	76

The reported rates of death from tuberculosis are approximately three times as high for Puerto Rico as for continental United States, and the rates for the United States decreased during the period from 1923 to 1929, while those for Puerto Rico were increasing. The increase in rate for Puerto Rico may indicate that conditions have been growing worse or that better diagnostic work is being done and more complete reports of deaths are being made. Public-health officers generally believe, as a result of a demonstration made in Framingham, Mass.,[28] that for every death from tuberculosis reported in a community nine active cases exist. On this basis, in 1926–27 when 3,842 deaths from tuberculosis were reported in Puerto Rico,[29] there would have been at least 34,578 active cases.

Such a high incidence of tuberculosis can not fail to have a very grave effect on the rates of morbidity and mortality in infancy and early childhood. What proportion of infants and young children in any community become infected is not known; but under the Puerto Rican conditions of crowding and inadequate diet, it would not be surprising to find that tuberculosis is playing a far more important part in the infant morbidity and mortality rates than is now suspected. In 1926–27, of the 3,842 deaths reported as caused by tuberculosis, 270 (7 per cent) were deaths of children under 15 years of age; of these 270, 27 were children under 1 year of age and 36 were children 1 to 2 years of age.[30] It is recognized now that infants and young children become infected with tuberculosis very easily and that the death rate among young infants so infected is very high, and it is known that the younger the infant the less likely is the diagnosis of tuberculosis to be made. It seems probable, therefore, that many of the deaths attributed to other causes, such as congenital debility, broncho-pneumonia, acute bronchitis, meningitis, or even enteritis, may have been due to tuberculosis.

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[24] Report of the Commissioner of Health of Puerto Rico for the Fiscal Year, 1927, p. 135. San Juan.
[25] Report of the Commissioner of Health of Puerto Rico for the Fiscal Year 1925, p. 112; 1927, p. 135; 1930, p. 70; and Twenty-Eighth Annual Report of the Governor of Puerto Rico, Fiscal Year 1928, p. 46.
[26] Mortality statistics (annual), 1923–1929. U. S. Bureau of the Census, Washington.
[27] Conditions due to the hurricane of 1928 undoubtedly were responsible for the unusually high tuberculosis death rates during the time immediately following it.
[28] Framingham Community Health and Tuberculosis Demonstration of the National Tuberculosis Association. Final Summary Report, 1917–1923, inclusive. Framingham, Mass., 1924.
[29] Report of the Commissioner of Health of Puerto Rico for the Fiscal Year 1927, p. 135.
[30] Report of the Commissioner of Health of Puerto Rico for the Fiscal Year 1927, Appendix Table, Mortality from Tuberculosis, and Appendix Tables 26 and 27.

In the present study it was found that of 449 families for whom a report was obtained concerning tuberculosis, 182 (41 per cent) gave a history of this disease; that is, some member of the family was reported either to have the disease at the time of the investigation or to have died of it. The history of tuberculosis was given by somewhat more families living in Ponce and in the crowded tenements of San Juan proper than in the less crowded districts on the outskirts of San Juan.

Syphilis.

At the time of the study it was the belief of the staff of the insular department of health that syphilis was very common in Puerto Rico, but no figures were available that gave an accurate picture of the incidence of the disease in the island as a whole. In the course of this investigation approximately 300 of the 506 families visited reported that Wassermann tests had been made and that in 66 of these (22 per cent) one or both parents of the children examined had positive reactions. It is probable, however, that this figure does not represent the true incidence of syphilis in the community, since the group studied were families known for one reason or another to the staff members of the department of health, and a certain proportion may have come to their attention because syphilis had been diagnosed or suspected. As will be pointed out in a later section (p. 33), the incidence of syphilis found at clinical examination in the children was relatively small compared with the reported incidence in the parents.

CAUSES OF DEATH AMONG CHILDREN

As part of the general inquiry regarding the health conditions under which the children were living, information was sought on the number of deaths that had occurred among the brothers and sisters of the children examined previous to the date of the interview. The total number of these deaths, the cause of death, and the age at death, as reported by the mothers, are shown in Table 1:

TABLE 1.—*Cause of death and age at death (as reported by mother); brothers and sisters of children examined in Puerto Rico*

Cause of death	Brothers and sisters of children examined					
	Total	Age at death				
		Under 1 month	1 month, under 6	6 months, under 1 year	1 year and over	Not reported
All causes	356	38	60	58	167	33
Causes known	293	28	53	57	151	4
Communicable diseases	102	8	19	24	49	2
Diseases of respiratory tract	29	1	5	5	18	
Diseases of digestive tract	50	1	9	13	27	
Malnutrition	67	7	10	15	35	
Diseases of early infancy	5	3				2
Diseases of nervous system	9	2	3		4	
External causes	6	2			4	
All other causes	25	4	7		14	
Causes unknown	63	10	7	1	16	29

The age distribution of the deaths that occurred among children under 1 year is strikingly different among this group of Puerto Rican

children from the distribution among children in the United States birth-registration area in 1927,[31] as is shown in the following comparison:

	Puerto Rico	U. S. birth-registration area [32]
Under 1 month	24 per cent	56 per cent
1 month, under 6 months	38 per cent	27 per cent
6 months, under 1 year	37 per cent	17 per cent

A proportion similar to that found in the present study is reported in a bulletin of the Department of Health of Puerto Rico by A. Fernos Isern and J. Rodriguez Pastor [33] who studied the ages at death of children dying in the first year of life.

Though the large proportion of deaths of Puerto Rican children over 1 month of age, and especially of those over 6 months, may be accounted for to a great extent by the high incidence of gastrointestinal diseases as a cause of death, it will be seen from the tabulation on page 12 that communicable diseases and diseases of the respiratory tract are also important as causes of death in this age period. Conversely, the relatively small proportion of deaths of infants over 1 month of age in continental United States may be accounted for by the reduction in the number of deaths from gastrointestinal diseases and, to some extent, communicable and respiratory diseases.

The large proportion of deaths from communicable disease among the children in the families studied in Puerto Rico—more than one-third of the total—is striking. Meningitis was said to have caused 40 deaths; tetanus, 18; measles, 14; influenza, 6; malaria, typhoid fever, and whooping cough, 5 each; tuberculosis of glands or of bones, 4; syphilis and diphtheria, 2 each; and scarlet fever, 1. The deaths from meningitis are of special interest. The reports of the commissioner of health for the years 1925 to 1927 include, each year, approximately 250 cases of simple meningitis, largely occurring in children under 2 years of age, but no cases of epidemic cerebrospinal meningitis. In the absence of this latter form of meningitis and in view of the known high rate of deaths from tuberculosis in the population as a whole, it would seem likely that the simple meningitis was in most instances of tuberculous origin. Of the 40 deaths from meningitis reported, 35 were said to have occurred in children under 2 years. That tuberculosis was not generally recognized in Puerto Rico as a cause of death in infancy and early childhood is brought out by the fact that no case of pulmonary tuberculosis was reported in this group, and only four cases of bone or gland tuberculosis.

Diseases of the digestive system and malnutrition together accounted for two-fifths of all the deaths reported; respiratory diseases for only one-tenth, a smaller proportion, perhaps, than might have been expected.

The causes of death here reported would indicate that a large proportion of the deaths probably are preventable. Control of tuberculosis and other communicable diseases, better food, and better economic conditions would undoubtedly do much toward reducing the mortality rate among children.

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[31] The age of death for Puerto Rican infants is that remembered and reported by the mother; the age of death in the United States birth-registration area is that given on the death certificate. The age reports are in all probability less accurate in Puerto Rico than in the United States, but the differences are so striking that they are given in spite of probable inaccuracies in the Puerto Rican percentages.

[32] Birth, stillbirth, and Infant Mortality Statistics, pt. 1, 1927, p. 186. U. S. Bureau of the Census. Washington, 1929.

[33] Estudio de la Mortalidad Infantil en Puerto Rico, p. 24. San Juan.

METHOD OF INVESTIGATION

During the 6 weeks of the study 584 children, in 534 families, ranging in age from 1 to 34 months, were given both physical and roentgenographic examinations. In most of the families 1 child was examined, the youngest. In 50 families 2 children were examined, the youngest and the next to youngest. Data on the socio-economic conditions under which these children were living were obtained at home visits to 506 families (556 children). The families of 28 of the children examined could not be visited.

The families of these children lived in the largest cities of the island, San Juan and Ponce. Some, including a few from the rural districts, lived on the outskirts of San Juan.

In order that the results of the examinations might be comparable with the material collected in the New Haven study, the method of investigation was duplicated as far as possible in every detail. The personnel—two physicians, two social investigators, a roentgenologist, and a secretary—was the same as that conducting the New Haven study; the technique of examinations, both physical and roentgenographic, was in all respects identical with that of the previous study; the same record forms were used by physicians and social investigators. The most variable element was the clinical judgment of the physicians. Though every attempt was made to maintain the same basis for judging the physical condition and development of the children as had been used in New Haven, it is probable that the great prevalence of poorly nourished children so influenced the physicians that the whole scale of clinical estimate was lowered from that used by them in New Haven. With regard to the clinical evidences of rickets, it is possible that the examiners, in their efforts not to overlook or discount signs that might be considered clinical evidences of the disease, counted signs as positive, which under other conditions would have been disregarded. It is possible that errors have been made, but if so, they have been made in the direction of reporting the nutritional condition of the children to be better than it actually was and of making diagnoses of clinical rickets when perhaps not wholly justified.

SOURCE OF MATERIAL AND SELECTION OF CASES

Examinations were made only in San Juan and Ponce, where roentgen-ray equipment was available. In San Juan they were made at the roentgen-ray laboratory of the insular department of health and at the Presbyterian Hospital; in Ponce, at the Hospital Asilo des Damas. At each of these institutions every consideration was given to the needs of the investigation. The division of the examinations between the two cities proved to be of considerable interest because of the difference in exposure to sunlight already referred to (p. 3) and in the economic condition of the people, which will be discussed in later sections.

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Most of the children examined were brought from the well-baby conferences conducted in San Juan and Ponce by the bureau of social medicine of the insular department of health. In San Juan a few of the children examined belonged in families living in the immediate neighborhood of the roentgen-ray laboratory of the department of health, and a few were brought to the Presbyterian Hospital clinic from the rural districts. Practically all were children already known to the visiting nurses of the department of health. The mothers with their babies and little children gathered at their local well-baby station and were taken to the place of examination in ambulances belonging to the department of health. An average of 20 children a day were seen.

The nurses who arranged for the children to be brought for examination were asked to select children who were under 2 years of age, principally infants under 1 year. Special effort was made to examine infants under 1 year, as the earliest roentgen-ray evidence of rickets had been found in children at this age in New Haven. The nurses were requested also to select supposedly well children, such as would be brought to a well-baby station, and to eliminate children who were known to have an infectious disease. (It was impossible to eliminate entirely children who were suffering from nutritional disorders, especially in the group over 1 year of age, and also a few children obviously having one infectious disease or another were seen.) As a result of this selection, the group of children examined probably did not represent a true sample of the children of Puerto Rican cities; they were probably somewhat better nourished and less likely to have an infectious disease than the average.

COLLECTION OF SOCIAL AND ECONOMIC DATA

The social and economic data were collected by two investigators who had gathered the same type of information in New Haven. Some adaptations in the method of collecting data were necessary because of the many differences in the customs of the people, their language, and their diet. Fortunately for the success of the study, nurses and social workers from the insular department of health were assigned to assist the Children's Bureau investigators and to act as interpreters. The familiarity of these local workers with the customs of the people made their help invaluable. A large proportion of this interpreting was done by nurses who already knew the families of the children.

Information was also sought regarding any illnesses that the child under observation had had, the occurrence in the family, so far as was known, of tuberculosis and syphilis, and the number of children in the family who had died, and the causes of these deaths, if known.

At the home visits information was obtained with regard to the social and economic situation of the family, their diet, and the availability of sunlight in the house or yard, as well as the family custom with respect to exposing infants to sunlight. A detailed discussion of each of these general subjects will be found in later sections, but it may be said here that the social and economic data covered in general the size and membership of the family and of the household; the number of rooms in which the household lived; the type of house or dwelling; the income on which the family was maintained and its source; the

employment of father and mother and of others in the household; and, if the father was unemployed, the period of unemployment.

The accuracy of the data regarding diets was at first seriously questioned by the investigators. By careful questioning, however, and by observation of the meals being prepared in the homes and the provisions being purchased in the markets, the investigators became convinced that the data were essentially accurate and gave a true picture of the food eaten by the families whose children were studied. The uniformity of the diets in the great majority of households was noticeable. The data recorded consisted of an estimate of the total quantity of certain foods purchased by the family for a week and the frequency with which they were used; a detailed statement of the food eaten by the mother on the day previous to the investigator's visit; estimates of variations in her diet during any recent periods of pregnancy and lactation; and as detailed a statement as possible of the food eaten by the child throughout his life.

PHYSICAL CONDITION OF CHILDREN EXAMINED

The general physical condition of the children was found to be far from satisfactory. Even from casual observation of the children in the streets, the examining physicians received the impression that many children were very poorly nourished, an impression that was fully corroborated by careful physical examinations. As has been pointed out, it is probable that the children who were examined belong to a group of families somewhat more intelligent than the average, who had taken advantage of the medical and nursing service offered by the health department. It is possible that the group was weighted with somewhat better nourished children than the average, especially among the younger children.

PHYSICAL EXAMINATION

Though a complete clinical estimate of the physical condition of a child should take into consideration all factors contributing to growth, development, and health, it was found essential in this investigation to limit the study of the physical condition to the factors that had a bearing on the development of rickets. Since rickets is primarily a disturbance of the nutritional processes, manifesting itself most strikingly in poor skeletal and muscular development, and since it is intimately associated with growth, as detailed a study as possible was made of those clinical evidences of satisfactory or unsatisfactory nutrition, which, when taken together, usually lead a physician to describe a child as "well nourished," "undernourished," or "poorly nourished." In addition to a clinical examination of the bones for the signs usually considered to be indicative of rickets, certain measurements were taken to show the amount of skeletal growth and of body weight, and estimates made of the amount of subcutaneous fat, the development of the muscles, the color of the mucous membranes, the degree of natural pigmentation of the skin, and the extent of tanning. Routine examinations of the skin, eyes, ears, nose, throat, heart, lungs, and abdomen were made, and any evidences of disease or other infection were recorded. Because of lack of time no systematic attempt was made to verify clinical impressions by laboratory procedures such as tuberculin or Wassermann tests or examination of blood or stools for parasites. Suggestion for follow-up of cases that needed treatment were made to the nurses in attendance at the clinic.

SEX AND AGE

Table 1a shows how the 584 children included in the study were distributed according to sex and according to age at time of examination. It will be seen that 320 (more than one-half the children whose ages were reported) were 1 year old or less at time of examination and that 171 (nearly one-third) were 6 months old or less. From the point of view of studying roentgenograms of the arm bones of young infants, this age distribution was satisfactory; from the point of view of study-

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ing growth and nutrition it would have been desirable to include also more older children.

There is no significant difference in the age distribution of the boys and the girls.

SKIN PIGMENTATION

Many degrees of skin pigmentation may be seen in the Puerto Ricans, varying from that characteristic of the south European to that of the full-blooded negro. Since, in temperate climates, the degree of skin pigmentation associated with race seems to influence in some way the susceptibility of children to rickets, and since, if rickets was found in Puerto Rico, it was desirable to know whether it occurred more frequently in the lighter or the darker children, the children were classified in four groups—according to whether their skin was light, medium, dark, or very dark.

TABLE 1a.—*Age at examination: boys and girls examined in Puerto Rico*

Age [1] at examination	Children examined					
	Total		Boys		Girls	
	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution
Total _____	584		308		276	
Age reported_____	564	100	296	100	268	100
Under 4 months_____	73	13	37	13	36	13
4 to 6 months _____	98	17	53	18	45	17
7 to 9 months _____	75	13	43	15	32	12
10 to 12 months_____	74	13	44	15	30	11
13 to 18 months_____	104	18	54	18	50	19
19 to 24 months_____	76	13	37	13	39	15
25 to 34 months_____	64	11	28	9	36	13
Age not reported_____	20	_____	12	_____	8	_____

[1] Age is given as of nearest month; that is, "under 4 months" is actually under 3 months and 16 days, "4 to 6 months" is from 3 months and 16 days to 6 months and 15 days, inclusive, and so on.

Of the 584 children examined, 239 were classified as light, 191 as medium, 122 as dark, and 29 as very dark; for 3 children no report was made. It is obvious that a large proportion of the children examined were but lightly or moderately pigmented, representing a preponderance of Spanish stock. For most purposes of this study the dark and very dark groups will be combined, since they represent, on the whole, children largely of negro stock.

It became clear at the beginning of the study that it would be impossible in many children to distinguish between pigmentation that was racial in origin and pigmentation that had been acquired by exposure to the sun. That an appreciable degree of the pigmentation was due to exposure is suggested by the definite preponderance in the light group of infants under 7 months of age, the age at which exposure to sun, with consequent tanning, was likely to be least common (see p. 19), and by the fact that the children in the medium and in the two darker groups were in general older than those in the light group. Undoubtedly the increasing depth of pigmentation that the older children showed was due, in some part at least, to the in-

creased exposure to the sun that took place as the children grew
older and were able to get outdoors by themselves.

Though it was assumed at the beginning of the study that Puerto
Rican children not only had access to sunlight that was adequate
to prevent rickets, but were probably exposed to it constantly, never-
theless it seemed worth while to record the presence or absence of
tanning of the skin, since this could be used as objective evidence
that such exposure had or had not taken place. It was, of course,
realized that the absence of tanning did not necessarily mean
that no exposure to the sun had taken place, since slight degrees
of tanning are difficult to recognize and may easily be overlooked in
persons whose skin is already somewhat pigmented. The presence
of tanning (distinguished from racial pigmentation whenever possible
by examination of parts of the skin that were usually covered with
clothing) was, however, taken as positive evidence of exposure to
sunlight, and has been used as such in connection with the study of
the roentgenograms of the bones and of certain aspects of the physical
examination.

Of the 584 children examined in Puerto Rico, 386 were reported
as tanned and 188 as not tanned; for 10 children no report was made.
Of the tanned children 79 were tanned on face, neck, and hands only,
245 on arms and legs in addition to face, neck, and hands, and 53
over the whole body; for 9 the extent of tanning was not reported.
Though many children under 7 months of age are customarily taken
out of doors almost daily, a large proportion of them do not receive
enough direct sunlight for tanning to show. At the examination of
children of this age group only one-third were found to be tanned.
It should perhaps be added, however, that even though in many chil-
dren the amount of exposure possible at this age is not sufficient to
produce tanning, nevertheless, as will be shown later, the exposure
is enough to prevent the development of rickets in practically all.[34]
During the second six months of life a considerable increase in expo-
sure evidently took place, since approximately three-quarters of the
children in this age group showed tanning. After this the proportion
showing tanning increased still more, until in the oldest group (19 to
34 months) it was found in more than 90 per cent.

That geographical conditions even within such a relatively small
territory as Puerto Rico may also make a difference in a child's expo-
sure to sunlight is shown by the fact that more of the children were
tanned in Ponce (76 per cent) than in San Juan, 35 miles away (63
per cent). This difference may be due partly to the difference in
structure of the houses (see p. 71), but it is probably due mostly to
the more continuous sunlight and drier climate of Ponce.

SKELETAL GROWTH AND BODY WEIGHT

Certain body measurements, namely, weight, height, and head cir-
cumference, were taken for the purpose of studying the general trend
of growth of this group of Puerto Rican children in comparison with
the trend of growth of children in continental United States as a whole
and in New Haven.

The weighing was done on balance scales by one of the public-health
nurses. The weight was taken with the child stripped and was re-

[34] The large proportion of children that are breast fed during their first eight months (see p. 93) and the
long daily exposure of the mothers to the intense sunlight should be mentioned in this connection.

corded in pounds and ounces, later converted into kilograms for the sake of having the unit of measurement conform to that of other series of measurements with which they were to be compared.

The measurements of height and head circumference were made by one of the physicians, assisted by a nurse, and recorded to the nearest millimeter.

The crown-heel length or height was taken with a measuring board [35] that had been used in similar studies in New Haven. The child was laid flat on his back in the concavity of the measuring board, with the crown of his head touching the headpiece of the board. The nurse held the child's head in this position and helped to keep his body straight and flat on the board. The crown-heel length was measured by bringing the footpiece into contact with the soles of both feet. Care was taken to read and record only measurements made when the footpiece was in contact with the child's heels, and not merely in contact with the balls of his feet. The knees were kept fully extended.

The occipito-frontal circumference of the head was measured with a steel tape drawn snugly around the head and the measurement recorded to the nearest millimeter. Care was taken to obtain the circumference of the largest part of the head.

In order to show the trends of growth among the Puerto Rican children, curves have been fitted [36] to the average weight, height, and head circumference of children of each month of age from 1 to 33 months—boys and girls—and these curves are shown in Charts I to IV. The trend of the weight-for-height relation is shown in Chart V by straight lines fitted to the average weight for height. In studying these trends the reader should bear in mind that the Puerto Rican children are a mixed group of Spanish and Negro stock, with possibly a slight admixture of Indian—a fact that among others may influence their growth in height.

For the sake of comparison trends of growth in weight and height for groups of children in continental United States, reported by the Children's Bureau in 1921, are shown also on the charts. The curves show the smoothed averages of weight for age and height for age for United States white children and the observed averages for weight and for height of United States negro children and for United States white children whose mothers were born in Italy.[37] Figures for children of Spanish stock are not available. Those for children of Italian mothers represent a south European group and are given as the next best basis for comparison.

The trend of growth in head circumference of the Puerto Rican boys and girls examined has been compared with that for white boys and girls measured in New Haven, excluding children of south European stock.[38] The curves are based on children 1 to 60 months of age; but as the Puerto Rican children included were all under 34 months, only the sections of the curves representing New Haven children under 34

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[35] The measuring board is 1 meter long, solidly constructed of well-seasoned, matched wood, with a concavity for the child to lie in and a meter measuring stick inlaid on each side. It has a fixed headpiece and also a movable footpiece that slides in two grooves, one on each side of the board, parallel to the meter measuring sticks. Measurements can be read on either of the two measuring sticks.

[36] Observed data, smoothed values, and equations of curves are given in Appendix A, p. 100.

[37] Statures and Weights of Children under Six Years of Age, by Robert M. Woodbury, pp. 85, 102, 104. U. S. Children's Bureau Publication No. 87. Washington, 1921.

[38] Data collected during study made by the U. S. Children's Bureau in cooperation with the department of pediatrics, Yale University School of Medicine (unpublished).

months are presented. The trends of growth in head circumference for negro children and for white children of south European stock (largely Italian) in New Haven so closely approximate the trends for New Haven white children (exclusive of south Europeans) that they are not reproduced.

Charts I to IV show that these Puerto Rican boys and girls were lighter in weight and shorter in height and had slightly smaller heads than the reported groups of white children of continental United States of the same age and sex, and that they were lighter in weight and shorter than the reported group of negro children and the reported
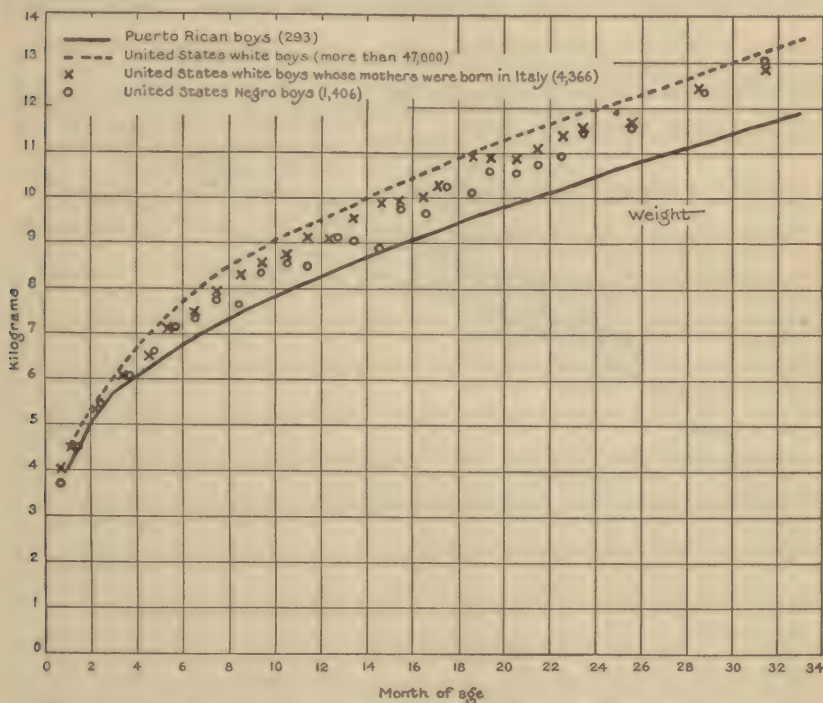
CHART I.—Average weight of boys 1 to 33 months of age examined in Puerto Rico, compared with averages for certain United States boys of the same age period

group of white children of Italian mothers. The difference in height between the Puerto Rican children and the white children of continental United States is roughly 2 centimeters or less during the period from 1 to 6 or 7 months, 3 centimeters from then to the thirteenth or fifteenth month, and 4 centimeters thereafter. The difference for both boys and girls from the sixth month onward is 4 to 5 per cent. The trends of growth in height for the Puerto Rican children after the first few months of life parallel fairly closely those for the white children of continental United States, and the monthly percentage increment in the two groups is fairly similar. Skeletal growth in height proceeds for both groups at approximately the same rate, though the average height of the Puerto Ricans is somewhat less than that of the white children of continental United States.

The difference in head circumference between the Puerto Rican children and the New Haven white children is practically constant throughout the age period represented by the curves.

The differences in weight, however, are striking. During the early months of the first year the differences between the Puerto Rican children and the white children of continental United States of the same sex are at a minimum—3 to 5 per cent for girls in the second, third, and fourth months, and 6 per cent for boys in the second and third months. With increasing age there is increasing difference in the average weights of the Puerto Rican girls and the white girls of continental United States, the maximum, 14 per cent, being reached
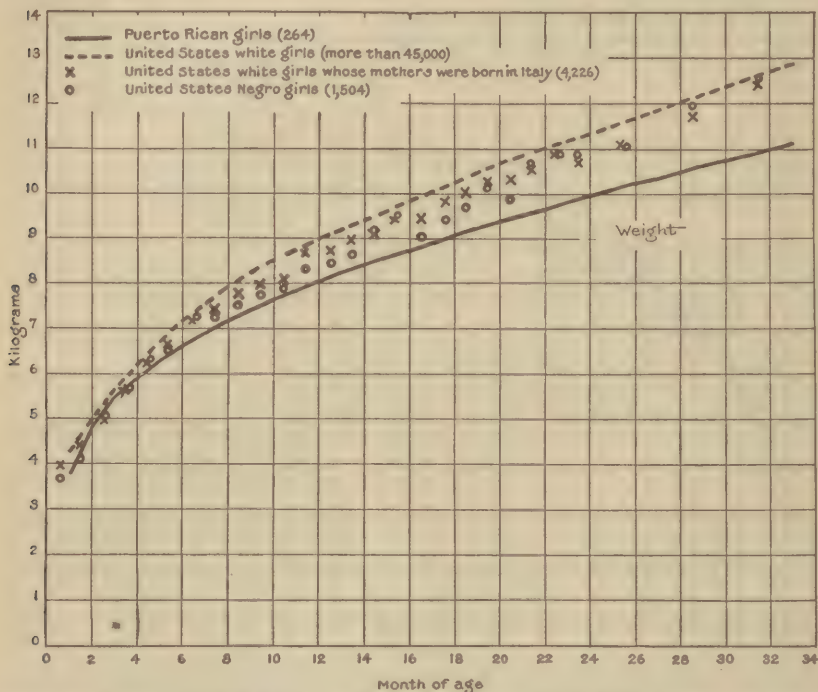
Chart II.—Average weight of girls 1 to 33 months of age examined in Puerto Rico, compared with averages for certain United States girls of the same age period

in the thirty-second and thirty-third months. In the averages for boys the maximum percentage difference (14 per cent) occurs between the ninth and eleventh months. From the twelfth to the twenty-third months the average Puerto Rican boy weighs 13 per cent less than the average white boy of the same age in continental United States, and from the twenty-fourth month onward 12 per cent less. The averages for negro children and for white children of Italian mothers (both in continental United States) are much closer to the averages for white children in continental United States than are the averages for the Puerto Rican children.

Differences in growth in height, weight, and head circumference for age are evident between Puerto Rican children and white children in continental United States. These differences appear in the skeletal framework and are indicated by the curves showing height

for age and head circumference for age.   The differences in average weight are proportionately greater than the differences in either stature or head circumference and are probably too great to be accounted for only by the Puerto Rican child's smaller skeletal framework.   In the early months of life the differences in height and weight are in general less than in later months.   Doubtless ethnic stock, climate, disease, and general economic and social conditions, such as family income and diet, affect the Puerto Rican children so as to lead to these differences.

Chart V shows the straight lines that have been fitted to the average weight for height of Puerto Rican boys and girls 1 to 33 months of age
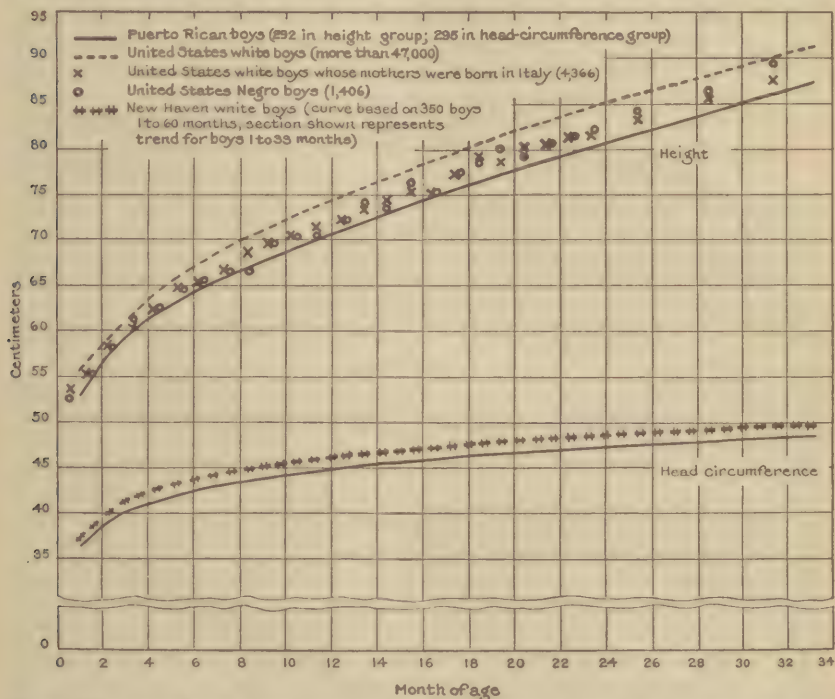
CHART III.—Average height of boys 1 to 33 months of age examined in Puerto Rico, compared with averages for certain United States boys of the same age period; average head circumference of same Puerto Rican boys compared with averages for white boys examined in New Haven

and to the average weight for height of white boys and girls in continental United States of approximately the same height as the Puerto Rican children.[38a]   Similar averages for negro and Italian children of this age group are not available.   The oldest children of the group of white children in continental United States were probably younger than the oldest of the Puerto Rican children studied.   The chart shows that the relation between height and weight among both boys and girls in Puerto Rico is very similar to that in continental United States.   The similarity of these weight-for-height curves suggests that these measures are not sufficient indexes of growth and development.   Certainly the general physical appearance of the children indicated that they were much below par according to clinical stand-

[38a] Statures and Weights of Children under Six Years of Age, by Robert M. Woodbury, p. 107.   U. S. Children's Bureau Publication No. 87.   Washington, 1921.
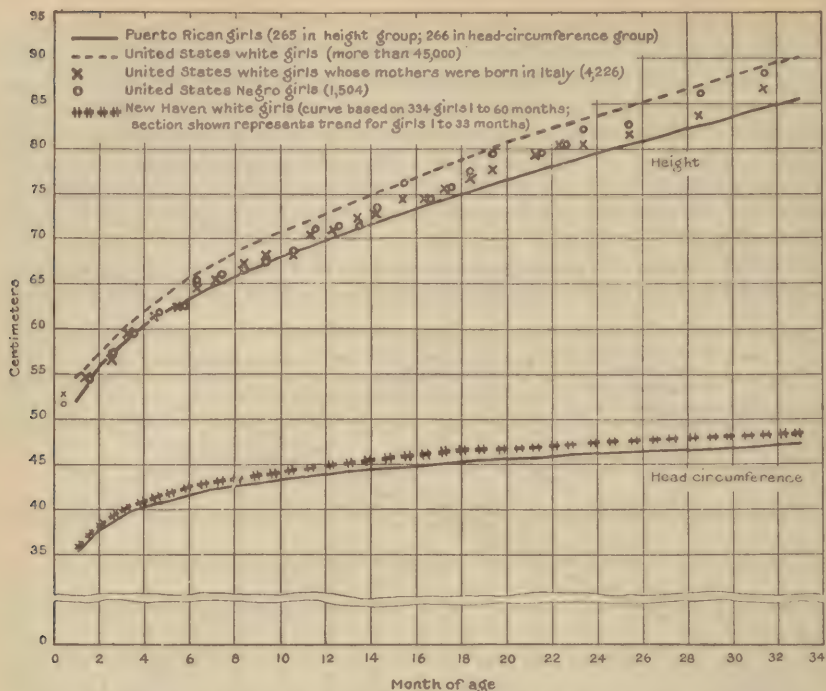
CHART IV.—Average height of girls 1 to 33 months of age examined in Puerto Rico, compared with averages for certain United States girls of the same age period; average head circumference of same Puerto Rican girls compared with averages for white girls examined in New Haven
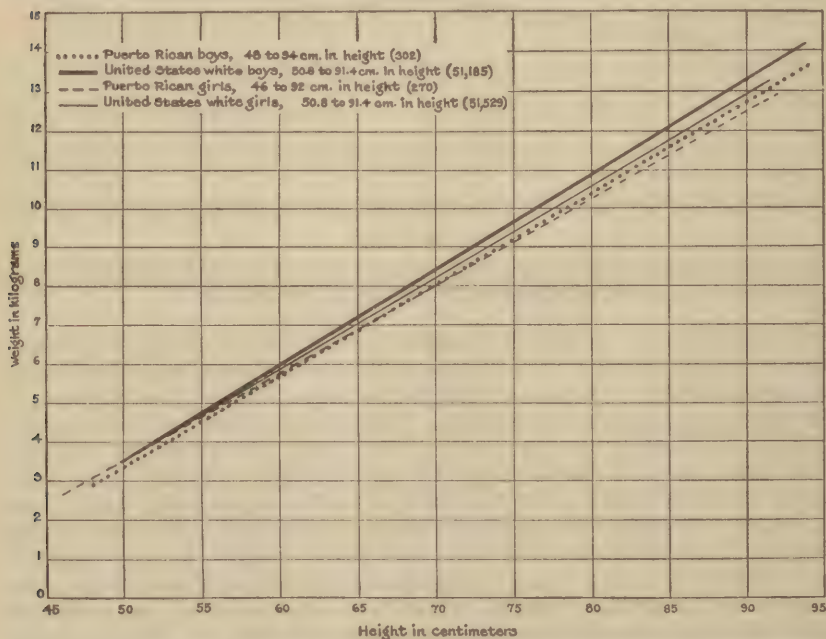
CHART V.—Average weight for height of boys and girls 1 to 33 months of age examined in Puerto Rico, compared with averages for United States white boys and girls of about the same height

ards used by physicians for judging the nutritional state of children in continental United States.

AMOUNT OF SUBCUTANEOUS FAT

There is no doubt that the general nutritional condition of the great majority of Puerto Rican children, as seen from a clinical point of view, was far from being as satisfactory as that of children in continental United States. Many of the most poorly nourished or atrophic children were in a class entirely outside the public-health experience of the physicians, and could be compared only with the children suffering from severe marasmus or starvation who are seen elsewhere in hospital wards. Excellently nourished children, moreover, were much less commonly found and then usually among the younger infants. The great mass of children belonged in a group whose nutritional condition would have been called fair or poor in continental United States. That the usual standard of gauging the physical condition of the children was not adhered to (because of the preponderance of poorly nourished children), but that a standard based on the range within the group itself was unintentionally substituted, will be shown later.

The amount of subcutaneous fat was estimated for each Puerto Rican child and a grade given, as had been done for the New Haven children, on a scale of five grades: Very good, good, fair, poor, and very poor. It is realized that such clinical estimates are subjective and may vary to a considerable degree according to the judgment of the physician making the examination. That they may also be influenced greatly by the variations and extremes within the group under observation at the time, is in general well recognized, and this has been illustrated clearly by the findings in the present study.

It was without question the intention of the physicians who made the examinations in Puerto Rico to use the same standards for estimating subcutaneous fat as they had used in similar studies in New Haven, and so to have comparable data from the two places. However, in the face of the preponderance of poorly nourished children and the scarcity of really well-nourished ones, the judgment of the physicians with regard to estimating amounts of subcutaneous fat rapidly became warped, and unintentionally there occurred, in conformity with the variations within the group, a definite readjustment in their whole scale of values, as has been pointed out. Children who in New Haven would have been considered to have a "fair" amount of subcutaneous fat, were, because of this unconscious readjustment of standards, reported as having a "good" amount, and those who in New Haven would have been considered to have a "poor" amount were reported as having a "fair" amount. There is little doubt that the ratings of the fat of these Puerto Rican children are high as compared with the ratings given in New Haven by the same physicians.

Even though the results of the estimates of subcutaneous fat for the two groups are not, therefore, comparable, it may be assumed that the distribution of grades within each group is descriptive of that particular group. Chart Va shows the percentage distribution of the grades of subcutaneous fat for children under 3 years of age—563 Puerto Rican children and 918 New Haven children, graphically recorded according to the scale descriptive of each group. It will be seen that, in spite of the differences in the descriptive scales, the Puerto Rican children have less satisfactory amounts of subcutaneous fat than the New

Haven children and also that there is a proportion of very poorly nourished Puerto Rican children that has no counterpart in the New Haven group. If, moreover, a readjustment of Puerto Rican grades were made by dropping each grade one point in order to bring the whole scale more nearly into correspondence with that used in New Haven, a better idea would be given of the actual contrast between the reasonably good condition of the New Haven children and the markedly unsatisfactory condition of the Puerto Ricans.

RELATION OF AMOUNT OF SUBCUTANEOUS FAT TO SEX, AGE, AND SKIN PIGMENTATION

The observers found no differences between boys and girls with regard to amount of subcutaneous fat. Study of the children by age groups, however, showed that the amounts of fat were on the whole more satisfactory for those who were under 7 months of age at the time of examination. That breast feeding is probably responsible for
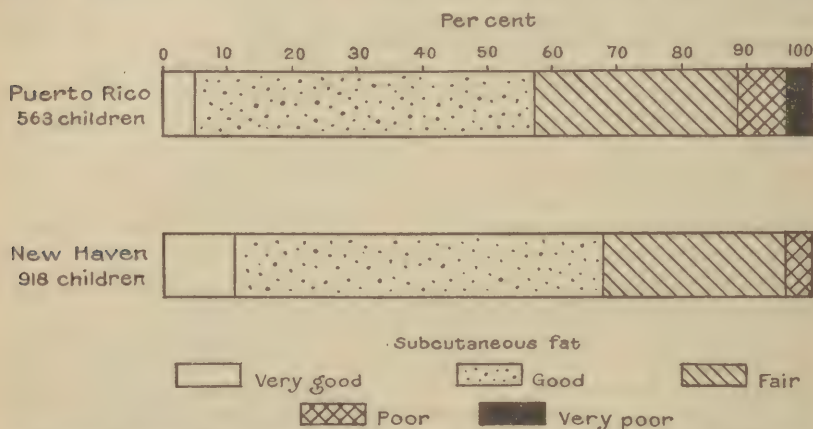
CHART Va.—Percentage distribution of grades of subcutaneous fat of children examined in Puerto Rico, compared with that of children examined in New Haven

this, and poor artificial feeding for the less satisfactory nutritional condition found in the later months, is a reasonable assumption; this will be discussed later.

It was the impression of the examiners that the children with the darkest pigmentation of the skin, that is, those who were predominantly Negro, had more satisfactory amounts of subcutaneous fat than those with lighter skin pigmentation, that is, those who were predominantly Spanish. This was shown to be true of the very dark group, since 26 out of 29 children in this group belonged in the "very good" or "good" grade for subcutaneous fat, and none in either the "poor" or the "very poor." The light and medium groups, on the other hand, each had fewer children in the "very good" and "good" grades than did the dark and very dark groups combined. It may be that the darker-skinned children tend to thrive better in the tropical climate than do the lighter-skinned ones. Whether or not this is because the darker groups are indigenous to the Tropics and can therefore thrive, whereas the lighter groups whose forebears came from temperate regions can not, is not known. It is, of course, possible that racial factors account for the better development of the darker children.

That exposure to sunlight may affect the nutritional processes directly, as in the prevention of rickets, is, of course, an accepted fact; that it may also affect other aspects of the nutritional process in some less direct way would seem to be possible.   In an effort to find out whether recent exposure to sunlight had affected the child's general nutritional condition, as evidenced by the amount of subcutaneous fat found at examination, the amount of subcutaneous fat found in children who were tanned was compared with the amount found in those who were not tanned.   A larger proportion of the children who were tanned than of those who were not tanned had relatively good amounts of subcutaneous fat.   Whether in this group of children living in the Tropics there is any real relation between exposure to sunlight and general nutritional condition as shown by the amount of subcutaneous fat, or whether the racial factors represented by the natural degree of pigmentation of the skin are of greater significance than the superimposed tanning, can not be determined from this small group of cases; but it seems clear that there is some association between the deeper degrees of pigmentation of the skin and the better amounts of subcutaneous fat.

MUSCULAR DEVELOPMENT

Since a child's muscular development is one of the indexes of his general physical condition and since it is commonly believed to be disturbed when rickets develops, an attempt was made to observe and estimate in a general way the muscular condition of each child at the physical examination, and to record the stage that he had attained in motor development.

It was the impression of the physicians that many more children in Puerto Rico than in New Haven showed weak, flabby muscles and relaxation of the joints and ligaments.   The lack of good muscular development shown by the Puerto Rican children was perhaps most striking in their lack of resistance when being handled during the course of the examination.   Many lay completely relaxed through the various procedures of the examination, without showing the ordinary child's resistance to being measured or to having a roentgenogram taken.   The most marked cases of muscular relaxation were found in the children who were most malnourished.   Poor muscle tone and relaxation of joints and ligaments seemed in general to accompany the less satisfactory amounts of subcutaneous fat; but, as will be shown later, there was no evidence that rickets had anything to do with the muscular condition.

Muscle tone and relaxation of joints and ligaments.

Nearly half (45 per cent) of the 553 children for whom a report was obtained showed either poor muscle tone or relaxation of joints and ligaments, or both.   Of those who showed poor muscle tone, more than three-quarters, as would be expected, also showed relaxation of joints and ligaments.   Poor muscle tone and relaxation both occurred more often in children who were over 6 months of age than in those who were under 6 months.

The association between unsatisfactory amounts of subcutaneous fat and poor muscular development, which seemed to exist at the time of examination, was borne out by the later analysis.   Three-fourths of the children with good muscle tone and nearly three-fourths of those with no relaxation of joints and ligaments were in the groups having

the more satisfactory amounts of subcutaneous fat.   In all age groups the child with poor muscular development was, in general, the one with the less satisfactory amount of subcutaneous fat.

Pot-belly.

One of the usual manifestations of poor muscular development is pot-belly.   It is common knowledge that this frequently occurs in the Tropics.   Of the 578 children for whom a report was obtained on this item, 278 (48 per cent) had pot-belly, 119 of the 578 (21 per cent) to a moderate or marked degree.   As will be shown later in the discussion of the clinical diagnosis of rickets, the presence of pot-belly, especially one of a moderate or marked degree, was occasionally the clinical evidence that swung a diagnosis from negative to questionable or from questionable to positive.   It is true that in northern climates pot-belly frequently accompanies rickets, but that it may accompany other less specific disturbances of nutrition is often overlooked.   When the child's diet consists largely of carbohydrates, as it does in the Tropics, the size of the pot-belly is undoubtedly increased by the distension of the intestines.   Practically half of the Puerto Rican children showed evidence of this poor musculature of the abdominal wall.   That pot-belly in these children was associated with poor nutrition and not with rickets is made clear by the negligible amount of rickets found at roentgen-ray examination.

Motor development: Age of holding up head, sitting up, standing, and walking.

The progress in the muscular development of a child may be judged, though perhaps somewhat roughly, by the age at which he is able to perform certain acts requiring muscular strength and coordination of different muscle groups, such as holding up the head steadily when the trunk is supported, sitting up unsupported on a firm surface, standing alone, or walking without support.   Since the first performance of these various acts takes place usually at rather definite stages during the first 15 or 18 months of a child's life, the ages at which such first performances occur may be taken in a general way as an indication of the progress of an individual child's muscular development, and these ages may be used to compare one group of children with another. Muscular development necessary to perform these acts at the usual age is dependent upon good health, proper nutrition, normal innervation of the groups of muscles used, and normal mental development.

Data concerning the ages at which these Puerto Rican children first held up their heads, sat up alone, stood alone, or walked alone were obtained from the mothers at the time of the home visit.   Many of the mothers had not observed carefully or could not remember exactly when their children were able to do these various things; therefore the ages reported should be considered as approximate.

Practically no sex differences were found in the ages at which each stage of motor development was accomplished, and therefore, the number of boys and girls have been combined for the sake of uniformity in presentation of the data.

Tables 2, 3, 4, and 5 show the ages at which the Puerto Rican children were reported to have held up their heads, sat up, stood, and walked, in comparison with the ages at which a group of unselected New Haven children were reported to have done these things.[38b]   The

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[38b] The New Haven group includes children of older ages than the Puerto Rican, but the proportion completing the various stages of motor development at the specified ages is probably not influenced by the differences in the age distribution.   For a comparison of the age at examination of the Puerto Rican and New Haven children see Table 12.

Puerto Rican children tended to stand and walk somewhat earlier than did the New Haven children. The ages at which Puerto Rican children first held up their heads and first sat up are somewhat more scattered in their percentage distribution than the ages at which the New Haven children reached the same stages of development.

TABLE 2.—*Age at holding up head; children examined in Puerto Rico and in New Haven, Conn.*

Age [1] at holding up head, as reported by mother	Children examined in Puerto Rico		Children examined in New Haven	
	Number	Per cent distribution	Number	Per cent distribution
Total	584		1,186	
Age reported	448	100	597	100
Under 2 months	22	5	18	3
2 months	155	35	168	28
3 months	152	34	262	44
4 months	63	14	110	18
5 months and over	56	13	39	7
Age not reported	56		481	
Not holding up head at date of examination	52		104	
Not reported whether holding up head	28		4	

[1]Age is given as of nearest month; that is, "under 2 months" is actually under 1 month and 16 days, "2 months" is from 1 month and 16 days to 2 months and 15 days, inclusive, and so on.

TABLE 3.—*Age at sitting alone; children examined in Puerto Rico and in New Haven, Conn.*

Age [1] at sitting alone, as reported by mother	Children examined in Puerto Rico		Children examined in New Haven	
	Number	Per cent distribution	Number	Per cent distribution
Total	584		1,186	
Age reported	346	100	697	100
Under 5 months	25	7	44	6
5 months	59	17	92	13
6 months	110	32	260	37
7 months	55	16	146	21
8 months	50	14	78	11
9 months and over	47	14	77	11
Age not reported	20		215	
Not sitting alone at date of examination	190		270	
Not reported whether sitting alone	28		4	

[1]Age is given as of nearest month; that is, "under 5 months" is actually under 4 months and 16 days, "5 months" is from 4 months and 16 days to 5 months and 15 days, inclusive, and so on.

TABLE 4.—*Age at standing alone; children examined in Puerto Rico and in New Haven, Conn.*

Age [1] at standing alone, as reported by mother	Children examined in Puerto Rico		Children examined in New Haven	
	Number	Per cent distribution	Number	Per cent distribution
Total	584		1,186	
Age reported	252	100	479	100
Under 8 months	36	14	25	5
8 months	56	22	50	10
9 months	48	19	82	17
10 months	48	19	104	22
11 months	29	12	76	16
12 months	25	10	68	14
13 months and over	10	4	74	15
Age not reported	31		237	
Not standing alone at date of examination	273		466	
Not reported whether standing alone	28		4	

[1]Age is given as of nearest month; that is, "under 8 months" is actually under 7 months and 16 days, "8 months" is from 7 months and 16 days to 8 months and 15 days, inclusive, and so on.

TABLE 5.—*Age at walking alone; children examined in Puerto Rico and in New Haven, Conn.*

Age [1] at walking alone, as reported by mother	Children examined in Puerto Rico		Children examined in New Haven	
	Number	Per cent distribution	Number	Per cent distribution
Total	584		1,186	
Age reported	219	100	520	100
Under 10 months	35	16	27	5
10 months	38	17	38	7
11 months	18	8	56	11
12 months	71	32	104	20
13 months	26	12	75	14
14 months	6	3	85	16
15 months and over	25	11	135	26
Age not reported	8		48	
Not walking alone at date of examination	329		614	
Not reported whether walking alone	28		4	

[1]Age is given as of nearest month; that is, "under 10 months" is actually under 9 months and 16 days, "10 months" is from 9 months and 16 days to 10 months and 15 days, inclusive, and so on.

Further comparison of the average age at which each stage of motor development was reached by the children in Puerto Rico and by those in New Haven shows differences which, though slight, indicate the earlier development of the Puerto Rican children. The average age of holding up the head for Puerto Rican children was 3 months; of sitting up, 6.7 months; of standing, 9.5 months; and of walking, 11.9 months. The average age of holding up the head for New Haven children was 3 months; of sitting up, 6.6 months; of standing, 10.6 months; and of walking, 13.5 months. There is no difference between the averages of the two groups with respect to holding up the head and sitting, but there is a significant difference in favor of the Puerto

Rican children of about a month in the average age of standing and of walking.

It is probable that various factors, many of which can not be evaluated, have to do with this tendency to slight precocity on the part of the Puerto Rican children. It would seem possible, however, that the slower growth in height and weight and the almost complete absence of rickets in the Puerto Rican group may have some direct bearing on the situation, since it is pretty generally recognized that children of the small, slender, wiry type tend to develop in motor skill earlier than those of the large, heavy type, and also that motor development may be delayed when rickets is in its active stages. The poor muscle tone and the greater degree of relaxation of the joints and ligaments observed at examination of these Puerto Rican children apparently did not affect their motor development. To what extent tropical sunlight (apart from its antirachitic effect), or differences in race, or habitual diet may influence muscular development can not, of course, be evaluated in such a small group of cases.

ONSET OF DENTITION

Closely associated with the growth and development of the skeleton in infancy is the development of the teeth. The age of eruption of the first deciduous teeth is often used as one gauge of physical development, and delay in eruption is thought to be one of the evidences of rickets. The age of eruption of the first teeth was reported by the mothers of 336 Puerto Rican children and is shown in Table 6. This table shows also the age of eruption of the first teeth for 706 New Haven children. Comparison shows that the teeth of Puerto Rican children tend to erupt earlier than those of New Haven children. The average age of first eruption of teeth reported for Puerto Rican children was 7 months, and that for New Haven children 7.3 months.

TABLE 6.—*Age at onset of dentition: children examined in Puerto Rico and in New Haven, Conn.*

Age [1] at onset of dentition, as reported by mother	Children examined in Puerto Rico		Children examined in New Haven	
	Number	Per cent distribution	Number	Per cent distribution
Total	584		1,186	
Age reported	336	100	706	100
Under 5 months	60	18	76	11
5 or 6 months	108	32	231	33
7 or 8 months	96	29	199	28
9 or 10 months	44	13	126	18
11 months and over	28	8	74	10
Age not reported	15		143	
No sign of teeth at date of examination	205		328	
No report on onset of dentition	28		9	

[1] Age is given as of nearest month; that is, "under 5 months" is actually under 4 months and 16 days, "5 or 6 months" is from 4 months and 16 days to 6 months and 15 days, inclusive, and so on.

COLOR OF MUCOUS MEMBRANES

Because of the generally poor physical condition of the children, and because of the high incidence in Puerto Rico of malaria, hookworm

disease, syphilis, and tuberculosis, any of which may be accompanied by anemia, it was thought worth while to make a rough estimate of the presence or absence of anemia as indicated by the pallor of mucous membranes. Though it would have been desirable to make accurate diagnoses of anemia by examination of the number of red blood cells and the amount of hemoglobin in the blood, such procedure was obviously impossible because of the limited time of the study. It was believed, however, that pallor of the mucous membranes of the eyelids and lips might be regarded as fair evidence of anemia, though not evidence from which the degree of anemia could be judged accurately.

Pallor of the mucous membranes of the eyelids and lips was found in 122 children (22 per cent of the 552 children for whom the condition was reported upon), a proportion strikingly higher than that found in a study of children in a city in continental United States.[39] In the latter study about 8 per cent of the children from 2 to 7 years of age showed pallor, and only 2.2 per cent of the children under 2 years. Among the Puerto Rican children examined, pallor was found in 27 per cent of the children 12 months of age and under and in 16 per cent of those 13 to 34 months of age. Pallor of the mucous membranes in these infants and young children was found to be associated with the less satisfactory amounts of subcutaneous fat, with poor muscular development, and with lack of evidence of exposure to sunlight. Only 14 per cent of the 315 children with "very good" or "good" amounts of subcutaneous fat showed pallor of the mucous membranes, whereas 49 per cent of the 71 children with the "poor" or "very poor" amounts showed this pallor.

It seems likely that such diseases as syphilis and tuberculosis and nutritional disturbances of infancy were the more important causes of this pallor. Most of the children examined lived in cities where the incidence of hookworm disease was relatively low. Moreover, only 6 per cent of the children for whom a report was obtained were found to have enlarged spleens—a low "spleen index" for a country in which malaria is more or less prevalent. Malaria, therefore, was probably a minor factor in the production of this pallor, since the spleen index of malaria is usually considerably higher in Puerto Rico, sometimes as high as 75 per cent in a community where malaria is prevalent.[40]

The association between pallor of the mucous membranes and lack of tanning of the skin is in all probability a significant one. The presence or absence of pallor and of tanning was reported for 545 children. Seventy-three per cent of the children whose mucous membranes were of good color were tanned, whereas only 48 per cent of those with pallor of mucous membranes were tanned. Apparently both exposure to sunlight and the grade of the child's nutritional condition as shown by the amount of subcutaneous fat are related to the color of the mucous membranes. The largest proportion of children with mucous membranes of good color were those with tanned skins and well-nourished bodies; the largest proportion of pale children were those with no tanning and less well-nourished bodies.

OTHER PHYSICAL FINDINGS

During the course of physical examination certain findings other than those which bore a direct relation to the child's nutritional condi-

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[39] Physical Status of Preschool Children, Gary, Ind., by Anna E. Rude, M. D., pp. 39, 78. U. S. Children's Bureau Publication No. 111, Washington, 1924.
[40] Report of the Commissioner of Health of Puerto Rico for the Fiscal Year 1925, p. 80.

tion were noted. Evidences of infection were specially sought, though as has been noted, the time at the disposal of the examiners did not permit the use of special tests, such as the tuberculin or the Wassermann tests.

The diagnoses, other than that of rickets, which were made at the time of the physical examination have been grouped as follows:

Nutritional disturbances			63
Malnutrition	54		
Gastroenteritis	9		
Communicable diseases			188
Rhinopharyngitis	117		
Laryngitis	2		
Bronchitis	27		
Broncho-pneumonia	1		
Tuberculosis	2		
Tuberculosis, suspected	16		
Fever, unexplained (probably due to communicable disease)	7		
Erysipelas	1		
Mumps	1		
Malaria	1		
Malaria, suspected	2		
Nasal diphtheria, suspected	1		
Congenital syphilis	3		
Congenital syphilis, suspected	5		
Dysentery	2		
Diseases of ears			3
Chronic otitis media	3		
Diseases of nose and throat			138
Hypertrophied tonsils or hypertrophied tonsils and adenoids	132		
Hypertrophied adenoids only	6		
Diseases of the eyes			18
Corneal scar and ectropion	1		
Conjunctivitis	11		
Gonorrheal conjunctivitis	1		
Stye	2		
Internal strabismus	3		
Diseases of central nervous system			9
Poliomyelitis, old, with paralysis	2		
Birth injury, probable	3		
Hydrocephalus	3		
Facial paralysis	1		
Genito-urinary diseases			9
Vaginitis	2		
Inguinal hernia	5		
Hydrocele	2		
Skin diseases			62
Impetigo	45		
Hemangioma	1		
Other skin diseases	16		
Congenital defects			52
Congenital heart disease	6		
Mongolian idiocy	1		
Mongolian idiocy, questionable	1		
Supernumerary fingers	2		
Tongue-tie	41		
Harelip	1		

The largest group of pathological conditions is that of communicable or infectious diseases because of the inclusion under this heading of the 117 cases of simple rhinopharyngitis (common cold). In a number of cases diagnoses of tuberculosis, diphtheria, or congenital syphilis were suspected, but could not be confirmed. Only 3 definite clinical diagnoses of syphilis were made at examination, but roentgenograms of the bones of the forearms showed syphilis to be present in 6 cases. The incidence of positive Wassermann tests in the parents has already been discussed. (See p. 12.)

Of 565 children whose tonsils, adenoids, and cervical lymph nodes were examined, 427 (76 per cent) had no obvious defect of tonsils or adenoids, 100 (18 per cent) had hypertrophied tonsils only, 31 (5 per cent) had both hypertrophied tonsils and hypertrophied adenoids, 6 children had hypertrophied adenoids only, and 1 child had hypertrophied and diseased tonsils, with no involvement of the adenoids reported. Comparison of these findings with those made by the same physicians in New Haven shows a considerably smaller proportion of children in Puerto Rico having hypertrophied or diseased tonsils or adenoids. In New Haven 39 per cent of the children of an age comparable to the Puerto Rico group had tonsils that were either enlarged or diseased, and 14 per cent had adenoids that either were definitely enlarged or seemed to be so. Whether the differences

in climate between New Haven and Puerto Rico can account for the difference in the proportions of hypertrophied or diseased tonsils found in these two communities can only be surmised.

Among the children examined were a relatively large number with skin infections, chiefly impetigenous in nature, and with conjunctivitis. An unusual number of children were found to have tongue-tie; no explanation of the great frequency of this defect was apparent.

In connection with these diagnoses made at the examination, it is of interest to note the diseases that these same children were reported to have had previous to the time of the study. Five hundred and thirty-two children were reported to have had one or more diseases; only 16 were reported to have had none. The diseases reported have been grouped as follows:

Colds	499	Earaches and otitis media	57
Diseases of digestive system	356	Wasting diseases	51
Diseases of skin	257	Convulsions	51
Diseases of respiratory system	148	Undefined fevers	23
Communicable diseases, positive or suspected	83	Diseases of nervous system	9
Diseases of eyes	68	Others	37

Colds were extremely prevalent among these children. Some form of disturbance of the digestive system was reported for two-thirds of them, of skin disease for about one-half, and of respiratory disease for more than one-fourth. The group of "wasting diseases" included various poorly defined conditions, locally known as *raquitismo*, or *fatigué*, that were probably due to frequent digestive disturbances or starvation or to tuberculosis, undiagnosed. It was noticeable that the digestive disturbances in children under 1 year of age were less frequent among breast-fed infants than among those artificially fed.

That communicable diseases other than colds were reported by relatively few mothers probably may be accounted for by the fact that the children were young and therefore had been comparatively little exposed to such diseases or by the fact that in many cases of illness they were not seen by a physician.

Because of the well-recognized association of the convulsions of tetany with rickets, it is of interest to note the high proportion (9 per cent) of children reported to have had convulsions in a group known to show, on the whole, almost no evidence of active rickets at the time of examination. The occurrence of a convulsion instead of a chill at the onset of an acute infectious disease is common in infancy and early childhood and may account partly for the relatively large number of convulsions reported.

Some comment may be made on the large number of cases of skin infections and of diseases of the eyes, and the question raised as to a possible relation between them and the inadequate diets that many of the children were receiving. The association between vitamin-A deficiency and xerophthalmia among children whose diets are low (or entirely lacking) in milk, butter, eggs, and green vegetables is well known; the association between vitamin-A deficiency and skin and respiratory infections is less well defined. That the children examined were receiving diets deficient in these foods will be pointed out later (p. 94).

INCIDENCE OF RICKETS IN PUERTO RICO

It has already been pointed out that the study here reported was undertaken in order to observe the roentgenographic appearance of the bones of infants living under the influence of tropical sunlight and to make comparisons between the roentgenographic appearance of the bones of such infants and that of the bones of infants examined previously in New Haven, Conn. Though the selection of Puerto Rico as the place in which to undertake this study of normal infants' bones was based on the presumption that the intensity of its sunlight would be adequate to prevent the development of rickets, nevertheless it was necessary to confirm this presumption by a careful study of the actual incidence of rickets in the island before the data there collected could be used with certainty as a normal control for the data collected in New Haven.

In the New Haven study it had been found that a relatively large proportion of infants, even though given what was thought to be a satisfactory amount of antirachitic treatment, showed sooner or later, if examined repeatedly by roentgen ray, certain deviations from the normal, which were interpreted as evidences of slight rickets. In the course of that study, moreover, the question was continually being raised whether these slight bone changes were in reality those of rickets or whether they were variations of normally growing bones. The study in Puerto Rico was undertaken in the belief that the presence of similar slight deviations from the preconceived normal in a tropical region, where presumably the sunlight was adequate to prevent rickets, would indicate that such deviations are not rickets but are variations within the normal, whereas the absence of these changes in Puerto Rico would tend strongly to confirm the opinion formed during the New Haven study that they are in reality the roentgenographic evidences of early rickets.

From a clinical point of view, also, questions had arisen with regard to the correct interpretation of certain skeletal findings. Was it possible that some of the slight skeletal signs, interpreted as those of rickets, were only variations in normal skeletal growth? It was hoped, when the study in Puerto Rico was undertaken, that the roentgenograms would establish clearly the differentiation between the roentgenographic appearance of the bones of normal infants and that of the bones of infants with slight or early rickets. It was hoped also that a better understanding of the clinical diagnosis of rickets could be reached. It was, of course, essential that the study should be carried out along the lines followed in New Haven.

A review of current literature shows that there has been some difference of opinion on the question of the prevalence of rickets in tropical regions. Hess[41] has reported his observations on rickets, made in 1928 in the West Indies, in Panama, and in Costa Rica. In Kingston, Jamaica, he found among the children at the General Hospital "many suffering from mild rickets, according to clinical criteria, although they did not present a rachitic appearance or pronounced

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41 Hess, Alfred F.: Rickets, Osteomalacia, and Tetany, pp. 54–55. Lea & Febiger, Philadelphia, 1929.

bowing of the legs.   This held true also for the children of the babies' welfare clinic."   In Trinidad, at the General Hospital, he found that "mild rickets was of common occurrence, but no case of severe rickets was seen."   Here, also, he found rickets in fully half the babies (all colored) that he examined at the babies' welfare clinic.

In hospital wards in San Jose, Costa Rica, Hess found "considerable rickets, some even of moderate degree," and on the Isthmus of Panama he found the same in two hospitals.   In the hospital at Ancon, Canal Zone, conducted by the United States Government, he saw "roentgenograms of rickets of mild and even marked degree which had developed in the Canal Zone."   He later studied roentgenograms of the epiphyses of about 100 children living in the region of the Canal Zone and found that eight showed definite signs of rickets, most of these children being between the ages of 4 and 6 months; six other children under 7 months showed questionable signs at the epiphyses.[42]

Furthermore, with regard to the protection of infants in these regions, Hess says: "But even under favorable circumstances, unless the babies are taken out of doors, they do not receive sufficient ultraviolet rays to protect them against rickets."   With the exception of the conclusions based on roentgenograms of children in the Canal Zone, Hess apparently based his conclusions on clinical observation only.

Other observers quoted by Hess apparently had never seen rickets in the West Indies or in Trinidad.   The differences in opinion were probably due to differences in the interpretation of clinical findings, a subject to which this report will refer later.   An article by Torroella[43] and one by Gonzales[44] state that no case of rickets was found during the examination of 6,000 children in Mexico.

In Puerto Rico, prior to the time of the investigation here reported, a large number of infants were reported every year to the insular department of health as having died of rickets.   It has long been the belief of the physicians of the department of health that these deaths should not have been so classified and that the confusion had resulted from the anglicization of the Spanish term "raquitismo"—meaning malnutrition—to rachitis or rickets.   In actual practice in Puerto Rico any severe wasting disease in infancy is called "raquitismo," just as in continental United States such a disease is called marasmus. The present investigation was, therefore, specially welcomed by the Department of Health of Puerto Rico, since it would help to clear up the question of whether or not rickets actually occurs in the island and since it might lead to greater accuracy in vital statistics.   That the term "rickets" as used on death certificates in Puerto Rico is a misnomer was shown clearly by the present investigation.   Its use in the vital-statistics reports was discontinued[45] in the year following the Children's Bureau study.

[42] Attention may be called to the fact that climatic conditions in the Isthmus of Panama are different from those in Puerto Rico and may well account for the rickets found there by Hess. In Colon, Republic of Panama, the daily average of actual hours of sunlight is 6.6, and in Ancon, Canal Zone, it is 5.9; both of these figures are lower than the average in either San Juan, P. R., or New Haven, Conn. (See p. 4.)   During the rainy season, which lasts seven or eight months, the monthly averages of actual hours of sunshine in Colon range from 4.6 to 6.7 daily. In Ancon, corresponding averages range from 4.2 to 4.8. Similar low figures are reached in New Haven only in the late fall and winter months, and in Puerto Rico not at all. (See Climatological Data for Central America, by W. W. Reed, in Monthly Weather Review, vol. 51, no. 3, March, 1923, pp. 133-141, published by the Weather Bureau, U. S. Department of Agriculture, Washington.)
[43] Torroella, Mario A.: Raisons pour lesquelles le rachitisme n'existe pas au Mexique. Archives de Médecine des Enfants, vol. 32, no. 5 (May, 1929), pp. 262-269.
[44] Gonzales, Martin: Raisons pour lesquelles le rachitisme n'existe pas au Mexique. Bulletins de la Société de Pédiatrie de Paris, vol. 27, Jan. 15, 1929, pp. 42-54.
[45] See Report of the Commissioner of Health of Puerto Rico for the Fiscal Year 1927, p. 132, and later reports.

NUMBER AND AGE DISTRIBUTION OF CHILDREN EXAMINED FOR RICKETS

Examination for rickets was made of 584 Puerto Rican children ranging in age from 1 to 34 months. Of these, 171 were under 7 months of age, 149 were 7 and under 13 months, 180 were 13 and under 25 months, and 64 were 25 months or over; the ages of 20 were not known. The preponderance of children under 13 months of age was a matter of selection, since the first year of life, and especially the first six months, is the period when the changes in the bones interpreted as the earliest evidence of rickets had been found in New Haven children, and therefore the period for which examinations were most desired in Puerto Rican children who were presumably free from rickets. The number of children examined in the second and third years was relatively small, but the results of the examinations indicate to some extent the incidence of rickets at this age.

METHODS OF EXAMINATION FOR RICKETS

When as accurate a diagnosis as possible is desired of the presence of rickets, not only should a physical examination be made to detect any clinical evidence of the disease, but roentgenograms of the long bones should be taken to determine whether any evidence of the disease is present and, if so, to determine the activity and severity of the process, and also to obtain a graphic record of deformities such as bowing of the bones of the legs. Supplementary chemical examination of the blood will aid the examiner in differentiating between an active process and one that is subsiding or healing, and also in making a very early diagnosis when rickets is suspected because of craniotabes or enlarged costochondral junctions but is not yet demonstrable in the roentgenograms of the radius and ulna.

In the investigation in Puerto Rico physical examinations were made of all children, the investigators laying special emphasis on examination for the signs generally accepted as manifestations of rickets. Roentgenograms were taken of the bones of the forearm only, since, as will be explained later, roentgenograms of these bones are the most satisfactory ones in making an early diagnosis of rickets. Opinions with regard to the rachitic origin of deformities such as bowlegs and knock-knees were formed from physical examination alone. In a few cases, as an aid to diagnosis, chemical tests were made to determine the calcium and inorganic phosphorus content of the blood serum.

Many elements enter into a clinical examination for rickets, making it a less reliable method of determining the real incidence of the disease in a community than a roentgen-ray examination. The fact that the child's skeleton is constantly changing with growth, the fact that many of the evidences of mild rickets are but slight variations from the normal, and the fact that the clinical judgments of different observers vary because these limits of normal can not be arbitrarily defined and because the observers differ in their training and experience make unreliable any study of the incidence of rickets based on clinical examination alone. On the other hand, roentgenographic examination has the advantage of presenting permanent records of certain attributes of the bones, which can be studied and reappraised by several observers and for which the limits of normal may be more clearly defined.

If a true picture of the incidence of rickets in a community is to be obtained, however, as many children as possible should be examined by both methods during the period of life when the disease is usually active—that is, the first two years of life—and also during the third and possibly the fourth year, when the disease is as a rule no longer active, but when the clinical evidences of previous disease should be found approximately in proportion to the roentgen-ray evidence of activity of the disease in earlier age periods.   The incidence of rickets found by roentgenographic examination during the first year or two of life should form, it is believed, some sort of background for the incidence to be found by clinical examination coincidentally or in later years.   It should be remembered, however, that the incidence of rickets found at clinical examination at any given age is the cumulative record of the more or less permanent effect on children's skeletons of a transitory disease which may have come and gone before that age or which may still be active at the time of examination.   Moreover, as will be pointed out later, the total number of clinical diagnoses of rickets probably includes a certain proportion of diagnoses of mild rickets that are incorrectly made, since they are based on skeletal signs not easily differentiated from those of normal growth and development.

DIAGNOSIS OF RICKETS BY CLINICAL EXAMINATION

Since it seemed desirable to compare the results of the physical examinations in Puerto Rico with those in New Haven, every effort was made to interpret the skeletal findings in Puerto Rico just as they had been interpreted in New Haven.   In retrospect it is believed that in the effort not to overlook any of the clinical evidences of possible rickets, too much emphasis may have been placed on slight variations, and a clinical diagnosis of rickets may have been made in some cases in which it was not warranted.   Since, however, similar conclusions had undoubtedly been drawn in New Haven, the clinical diagnoses have been retained as made, and have been analyzed in some detail to show how varied and inconsistent were the observations upon which the diagnoses were based.   It should be borne in mind, however, that the phrase "clinical diagnosis of rickets" as used in this study does not mean that rickets was necessarily present as an active disease; indeed, in a majority of cases the evidence was only such as might have been produced by previous rickets of a mild degree, and few cases of active rickets were even suspected at physical examination.

INCIDENCE OF RICKETS AT CLINICAL EXAMINATION AND ITS RELATION TO AGE

Examinations for clinical evidences of rickets were made on 584 children.   The diagnoses made and the ages of the children at the time of examination are shown in Table 7.   It will be seen that in only 50 children (9 per cent) was the evidence sufficient to lead to a definite diagnosis of rickets, in 134 it was sufficient to lead to a questionable diagnosis, and in 400 there was no evidence of rickets.   Of the 50 cases in which the clinical diagnosis of rickets was definite, 46 were considered to be of slight degree, 3 of moderate degree, and 1 of marked degree.   (See case 1, Appendix E, p. 120.)

It will be seen also from Table 7 that the proportion of children showing signs interpreted as evidences of rickets or of questionable rickets was considerably smaller in the age group under 7 months than

in any other, and that the proportion showing no evidence of rickets was largest in the age group under 7 months. Though this is not incompatible with the usual increase in the incidence of clinical evidences of rickets during the later months of infancy and the early months of childhood, the fact that it occurred in these Puerto Rican children who were exposed constantly to intense sunlight suggests that in some cases the process of growth and development of the bones may alone account for the slight signs commonly used as a basis for the clinical diagnosis of mild rickets.

TABLE 7.—*Clinical diagnosis of rickets and age of child at examination; children examined in Puerto Rico*

Age [1] at examination	Children examined in Puerto Rico										
		Clinical diagnosis of rickets									
	Total	No rickets		Questionable diagnosis		Slight		Moderate		Marked	
		Number	Per cent [2]	Number	Per cent [2]	Number	Per cent [2]	Number	Per cent [2]	Number	Per cent [2]
Total	584	400	68	134	23	46	8	3	1	1	(3)
Under 7 months	171	143	84	25	15	3	2	---	---	---	---
7 to 12 months	149	94	63	39	26	14	9	1	1	1	1
13 to 18 months	104	65	63	26	25	12	12	1	1	---	---
19 to 34 months	140	83	59	39	28	17	12	1	1	---	---
Not reported	20	15	--	5	--	--	--	--	--	--	--

[1] Age is given as of nearest month; that is, "under 7 months" is actually under 6 months and 16 days, "7 to 12 months" is from 6 months and 16 days to 12 months and 15 days, inclusive, and so on.
[2] Per cent not shown where number of children was less than 50.
[3] Less than 1 per cent.

PHYSICAL SIGNS USED AS BASIS FOR CLINICAL DIAGNOSIS OF RICKETS

The clinical diagnoses of rickets made in Puerto Rico were based in large part upon certain skeletal signs usually considered to be evidences of the disease, but also to some extent upon certain signs of muscular weakness, which were regarded as secondary rather than primary diagnostic evidence. Analysis of the data shows that both the number of these signs and the degree of deformity presented by each were taken into consideration when the diagnosis was made. It is evident, moreover, from study of the records, that some skeletal signs appeared much more frequently than others and that certain signs or combinations of signs clearly were given more weight by the examiners in the diagnosis of rickets than others. When the diagnosis of rickets was questioned, it was done either because the skeletal signs were few, usually only one or two having been found, or because they were present in such slight degree that their significance was questioned. The difference in the degree in which the signs were present probably accounted most frequently for the differences in the diagnoses made when the same group of skeletal signs were present. Because of the great variety of factors entering into a clinical diagnosis of rickets it is to be expected that many inconsistencies in diagnosis would appear. Lastly, it should not be forgotten that a diagnosis often depends on the observer's impression of the child as a whole, a very subjective and unreliable factor, but one that enters into nearly every clinical diagnosis and may account for many inconsistencies.

The skeletal signs that were considered as clinical evidence of rickets were: Enlargement of the costochondral junctions of the ribs, enlarge-

ment of the epiphyses of the long bones (especially those at the wrist), bowlegs, knock-knees, Harrison's groove, pigeon-breast, moderate enlargement of the parietal or the frontal bosses or both, craniotabes, and asymmetry of the head. The evidences of muscular weakness that were considered as giving contributory evidence of rickets were: Decreased muscle tone, increased relaxation of the joints and ligaments, and pot-belly. A scale ranging from what was considered normal through two or three degrees of enlargement or deformity was adopted for each sign. That different physicians should use a scale consistently is scarcely to be expected. In this study the examinations were made by two physicians who had made many of the examinations in New Haven, and, though, undoubtedly, individual judgment varied to some extent, the conclusions drawn were, on the whole, fairly consistent.

Relation of number of skeletal and muscular signs to clinical diagnosis of rickets.

It became apparent from study of the records that the observers when making the clinical diagnoses took into consideration not only which skeletal signs were present but also how many. Though analysis showed that the observers were influenced more by certain skeletal signs than by others, it also shows that, regardless of what the signs were, the greater the number of signs found the more likely was it that a diagnosis of rickets would be made. (See Appendix Table B1, p. 110.) A similar relation was found between the number of signs of muscular weakness and the clinical diagnosis, indicating probably that these signs influenced the diagnosis when it was uncertain on the basis of skeletal signs alone.

Incidence and degree of each skeletal sign.

More important in attempting to understand the basis for the clinical diagnosis of rickets than the number of signs is the incidence of certain skeletal signs and the degree in which they were observed. The inconsistencies of clinical judgment in making such diagnoses may be demonstrated also by analyzing the diagnoses made when various signs or combinations of signs were present. The following detailed study of the skeletal signs found in Puerto Rican children is given in an attempt to throw some light on their value in diagnosis, and in order that comparisons may be made by other observers as to the relative frequency and severity of these signs in communities having differing degrees of intensity of sunlight.

The incidence, in the total group of children examined in Puerto Rico, of each of the skeletal signs usually considered to be evidence of rickets compared with the incidence in a group of children of about the same age examined in New Haven is shown in Table 8. The percentage incidence of each sign in the two groups of children is as follows:

	Puerto Rico	New Haven
Enlarged costochondral junctions	16	58
Enlarged epiphyses at wrist	10	55
Bowlegs	30	50
Knock-knees	28	23
Harrison's groove	6	25
Pigeon-breast	(46)	2
Moderate enlargement of—		
Either frontal or parietal bosses	7	27
Both frontal and parietal bosses	1	15
Asymmetry of head	6	(47)
Craniotabes	1	4

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[46] Less than 1 per cent.   [47] Not reported.

TABLE 8.—*Incidence of skeletal signs usually considered evidence of rickets: children examined in Puerto Rico and in New Haven, Conn.*

Skeletal signs	584 children examined in Puerto Rico (1 to 34 months of age)				956 children examined in New Haven (1 to 36 months of age)			
	Total reported	Signs present	Signs absent	Not reported	Total reported	Signs present	Signs absent	Not reported
Enlarged costochondral junctions____	581	92	489	3	954	549	405	2
Enlarged epiphyses at wrist_____	583	60	523	1	952	519	433	4
Bowlegs _____	582	176	406	2	¹ 547	276	271	² 409
Knock-knees _____	¹ 303	85	218	² 281	¹ 555	127	428	² 401
Harrison's groove_____	583	37	546	1	951	233	718	5
Pigeon-breast_____	577	1	576	7	954	15	939	2
Moderate enlargement of—								
Either frontal or parietal bosses__	583	43	536	1	950	259	545	6
Both frontal and parietal bosses__		4				146		
Asymmetry of head_____	551	33	518	33	(³)	(³)	(³)	(³)
Craniotabes_____	581	5	576	3	945	37	908	11

¹ Includes only children who were standing at date of examination.
² Children not yet standing at date of examination.
³ Not reported.

It will be seen that the incidence of each of the signs, with the exception of knock-knees, is considerably lower in Puerto Rico than in New Haven. That the high incidence of rickets as shown by the roentgen-ray examination in the New Haven group (approximately 30 per cent) plays an important part in this difference is undoubted, but that these signs may occur also in slight degree in children who have not had rickets is made evident by the occurrence of these signs in Puerto Rico, where, as will be shown later, rickets is in reality a rare disease.

In a very large proportion of cases in which the skeletal signs were found in Puerto Rican children, they occurred only in a very slight or slight degree. It is probable that most of the signs recorded as occurring to a very slight degree were within the range of normal and were given little weight by the observers when making the diagnoses. The weight given to signs occurring in a slight degree varied, apparently depending on the presence of other skeletal signs or on evidences of muscular weakness. Skeletal signs were reported to have occurred in a moderate degree in relatively few instances; but when they did so occur, more weight, as would be expected, was given to each one in making the diagnosis.

Table 9 shows the degree in which each skeletal sign was present among the Puerto Rican children and indicates the frequency with which a clinical diagnosis of rickets was made in the presence of each sign. The ultimate diagnosis was, of course, made by consideration of all the signs, both skeletal and muscular, that were found in each case. A detailed tabulation of the combinations of skeletal signs found in each of the 584 children will be found in Appendix Table B2.

Table 9 shows that a positive diagnosis was made in approximately half the children with a Harrison's groove, in one-third of those with either enlarged costochondral junctions or enlarged epiphyses at the wrist, in one-fifth of those with moderately enlarged parietal or frontal bosses, in one-sixth of those with bowlegs or knock-knees, and in one-eighth of those with asymmetrical heads. It is apparent that the observers must have felt that the presence of enlarged costochondral junctions, enlarged epiphyses at the wrist, and a Harrison's groove

was more definite evidence of rickets than was the presence of either slight bowing of the legs or slight knock-knees. As would be expected when either bowlegs or knock-knees occurred in a moderate degree, a clinical diagnosis of rickets was more likely to be made than when it occurred in a slight degree, but the diagnosis was not necessarily considered positive just because one of these signs was present to a moderate degree.

TABLE 9.—*Skeletal signs usually considered evidence of rickets and degree in which these signs were present in relation to clinical diagnosis of rickets; children having these signs who were examined in Puerto Rico*

Skeletal signs	Total	Children having skeletal signs					
		Clinical diagnosis of rickets					
		No rickets	Questionable diagnosis	Rickets			
				Total	Slight	Moderate	Marked
Costochondral junctions	92	9	50	33	30	2	1
Slight enlargement	89	9	50	30	28	2	......
Moderate enlargement	3	......	......	3	2	......	1
Epiphyses of long bones at wrists (slight enlargement)	60	9	30	21	19	1	1
Bowlegs	176	90	57	29	28	1	......
Slight	153	89	45	19	19	......	......
Moderate	23	1	12	10	9	1	......
Knock-knees	85	51	20	14	13	1	......
Slight	68	45	14	9	9	......	......
Moderate	17	6	6	5	4	1	......
Harrison's groove	37	3	15	19	15	3	1
Slight enlargement	34	3	14	17	14	2	1
Moderate enlargement	3	......	1	2	1	1	......
Pigeon-breast, slight	1	......	......	1	......	1	......
Parietal or frontal bosses	47	13	24	10	8	1	1
Parietal or frontal bosses moderately enlarged	43	13	23	7	7	......	......
Parietal and frontal bosses moderately enlarged	4	......	1	3	1	1	1
Asymmetry of head	33	20	9	4	3	1	......
Slight	31	18	9	4	3	1	......
Moderate	2	2	......	......	......	......	......
Craniotabes	5	1	2	2	1	......	1
Slight	4	1	2	1	......	......	1
Moderate	1	......	......	1	1	......	......

The reports were analyzed to find out whether there was any significant difference in the incidence of these skeletal signs as found by the two physicians. With the exception of a more frequent report of Harrison's groove by one observer and of moderately enlarged parietal or frontal bosses by the other, there were no significant differences.

The following discussion of the incidence and degree of each of the skeletal signs usually thought of as indicating rickets brings out some

points of interest in interpreting their occurrence in this tropical region as compared with their occurrence in New Haven.

Bowlegs.—Bowlegs were found less often in Puerto Rico than in New Haven. Though in 30 per cent of the Puerto Rican children examined bowlegs were found to be present in a degree that was considered outside the limits of normal, they were also found in a less degree in an additional 49 per cent not shown in the table. It is probable that most of these cases of bowing, whether considered within the limits of normal or not, were in reality only exaggerations of the normal curves due, in many cases, not to rickets but to the mother's habit of carrying the infant astride her hips. In this position the infant, though supported by the mother's arm or a sling, soon learned to help support himself by clinging with his legs to his mother's body. The tendency was, therefore, for the natural bowing of the child's legs to be increased.

No case was found of the bowing of the lower third of the legs that is so characteristic of rickets.

Knock-knees.—Knock-knees (estimated only for children who could stand at the time of examination) was found in Puerto Rico in nearly as large a proportion of cases as was an abnormal degree of bowing; but unlike bowing, it occurred even more often in Puerto Rico than in New Haven. Since in many cases the knock-knees disappeared when the child was placed in a prone position and the knees brought together it seems probable that the knock-knees were not due to any bony deformity such as might be produced by rickets.

Furthermore, in no case were the knock-knees asymmetrical—the type of knock-knees characteristic of severe rickets.

Enlarged costochondral junctions and epiphyses of long bones at wrist.— The incidence of enlarged costochondral junctions and of enlarged epiphyses of the long bones at the wrist was strikingly lower in Puerto Rico than in New Haven. The difference may be attributed, in all probability, to the difference in climate and the consequent difference in the incidence of rickets in the two localities. The fact, however, that even 16 per cent of the Puerto Rican children examined were thought to have had slight enlargement of the costochondral junctions, and 10 per cent had slight enlargement of the epiphyses at the wrist (whereas, as will be shown later, in only 1 per cent was evidence of rickets found by roentgen ray) suggests either that the presence of such enlargement does not always indicate the presence of rickets or that the observer's impression of enlargement is sometimes incorrect. Moreover, it may be pointed out that in New Haven a slight degree of enlargement of the epiphyses at the wrist had apparently been present in a number of children who showed no evidence of rickets even on repeated roentgenographic examination of the bones of the forearm. There is little doubt, therefore, that in Puerto Rico, as in New Haven, a number of cases of slight enlargement of the epiphyses of the wrist and probably also of the costochondral junctions are the result of physiological growth and development, and are not necessarily pathological. Probably it is impossible to distinguish with certainty between the slight enlargement due to rickets and that due to normal growth.

Harrison's groove.—Harrison's groove was found in only one-fourth as many children in Puerto Rico as in New Haven. In 15 of the 37 children showing this sign hypertrophied tonsils or adenoids, or both,

were also found, and in 14 additional children there was enlargement of the cervical lymph nodes, probably indicating infection in the nose or throat.   This association in Puerto Rican children of Harrison's groove with hypertrophy of the lymphoid tissues of the nose and throat suggests that obstruction of the respiratory passages due to simple hypertrophy or to infection may be one of the underlying causes of this deformity.   The greater incidence of Harrison's groove among New Haven children indicates without much doubt, however, that rickets increases the frequency with which this sign occurs.

Head signs.—The shape of the children's heads in Puerto Rico, probably a racial characteristic, was very different from that most frequently seen in New Haven, although in the latter city heads similar in shape to those found commonly in Puerto Rico were occasionally found among both negroes and whites.   A large proportion of the Puerto Rican children had heads that were narrow and low in the frontal region, broad and high in the parietal, and more or less flat in the occipital; the New Haven children's heads were characteristically squarer or rounder in shape, with prominent or high foreheads.   In Puerto Rico this usual breadth of head in the parietal region commonly gave the impression that the parietal bosses were somewhat enlarged; but unless either the parietal or the frontal bosses, or both, appeared to be at least moderately enlarged, the child's head was not considered abnormal.   Moderately enlarged frontal bosses were comparatively rare in Puerto Rico, the great majority of diagnoses of abnormal heads having been based on moderate enlargement of the parietal bosses only.   It is doubtful, however, whether the heads should have been considered abnormal unless the frontal bosses were enlarged also, since even moderately enlarged parietal bosses were probably only exaggerations of the shape characteristic of the Puerto Rican heads in general.   On the whole, however, neither moderately enlarged parietal nor moderately enlarged frontal bosses were common in Puerto Rico as compared with New Haven.

Craniotabes was found in five Puerto Rican children.   For two the roentgenograms showed rickets (see case histories 1 and 4 in Appendix E, p. 120), and for these two clinical diagnoses of rickets were also made. Three children showed no rickets by roentgenogram.   They were 2, 3, and 4 months of age and showed slight craniotabes as the only clinical sign of the disease.   Positive clinical diagnoses were not made in these three cases.   None of the five children showed evidence of syphilis either at physical examination or by roentgenogram.

RELIABILITY OF CLINICAL DIAGNOSIS

That the clinical diagnoses of rickets made on these Puerto Rican children were based in large part on relatively slight evidence and were not made consistently has already been indicated.   This may be seen even more clearly by studying the various combinations of skeletal signs and the diagnoses made from each combination, as shown in Appendix Table B2 (pp. 111–112).[48]   Though in retrospect the basis for diagnosis seems inadequate in a number of cases, it should be remembered that a similar basis for diagnosis is often used in temperate climates and is assumed to be justified because a relatively large

[48] It should be pointed out, however, that this table does not include signs of muscular weakness, such as pot-belly or poor muscle tone, which no doubt influenced the diagnosis in many cases, nor does it show the degree of the skeletal signs, as does Table 9.

proportion of such diagnoses can be corroborated by other methods of examination. The fact (as will be pointed out later) that there is no basis for belief that rickets exists among the Puerto Rican children examined except as a rare disease, together with the fact that most of the clinical diagnoses of rickets made in Puerto Rico could not be corroborated by roentgenograms, throws doubt not only on the diagnoses made in Puerto Rico but also on a certain number of the diagnoses made on similarly slight evidence in temperate climates. Probably it is impossible to distinguish clinically between the skeletal changes in the long bones that are within the limits of normal growth and development and those that are the result of a slight degree of rickets.

That the clinical diagnoses of rickets in Puerto Rico, based on skeletal signs that deviated but little from the preconceived standard of normal, were probably unreliable will be shown in the following analysis of the roentgenographic findings.

DIAGNOSIS OF RICKETS BY ROENTGENOGRAPHIC EXAMINATION

Roentgenograms were taken of the radius and ulna of the 584 children who were given physical examinations by the same technique as that previously used in New Haven. (See Appendix C, p. 113.) Of all the long bones the radius and ulna are the most satisfactory to use for the early diagnosis of rickets, since the examination of these presents fewer technical difficulties than examinations of other bones. Though rickets probably always develops in the ribs before it develops in the ulna, the difficulty of obtaining good roentgenograms of the costochondral junctions is so great that study of the development of rickets in the rib by this method is practically out of the question. Besides, the thickness of the femur or tibia and the irregularity at the diaphyseal-epiphyseal junction makes the use of these impractical. Because of its smaller and more uniformly regular epiphyseal surface, the ulna is even more satisfactory than the radius for the early diagnosis of rickets.

INCIDENCE OF RICKETS AT ROENTGENOGRAPHIC EXAMINATION AND ITS RELATION TO AGE

The diagnoses of rickets made from the roentgenograms are shown in Table 10. That rickets is actually very rare in Puerto Rico as compared with New Haven is shown by the fact that for only 5 children was there definite evidence in the roentgenograms that the child had rickets or had had it previously. Three of these children (all less than 6 months of age) showed changes in their bones comparable to those found commonly in young infants in New Haven and interpreted there as very slight or slight rickets; 1, who had lived all his life (until 2 weeks before examination) in a stone cellar apartment lighted only by electric light, showed severe, active rickets; and 1 showed the scars of an old process (probably one of moderate degree at the time of its activity) which had occurred when she lived in New York City and which had healed some months before the time of the study. The total incidence of rickets in the 584 children examined was less than 1 per cent.

TABLE 10.—*Roentgen-ray diagnosis of rickets and age at date of examination: children examined in Puerto Rico*

Age [1] at examination	Children examined in Puerto Rico									
		Roentgen-ray diagnosis of rickets								
		No rickets		Doubtful diagnosis		Rickets				
	Total					Total		Active, marked	Slight, healing	Slight, healed
		Number	Per cent	Number	Per cent	Number	Per cent			
Total	584	509	87	70	12	5	1	1	3	1
Under 4 months	73	60	82	12	16	1	1	------	1	------
4 to 6 months	98	67	68	29	30	2	2	------	2	------
7 to 9 months	75	62	83	12	16	1	1	1	------	------
10 to 12 months	74	62	84	12	16	------	------	------	------	------
13 to 18 months	104	99	95	5	5					
19 to 24 months	76	76	100	---	---	-				
25 to 34 months	64	63	98	------	------	1	2	------	------	1
Not reported	20	20	------	-						

[1] Age is given as of nearest month; that is, "under 4 months" is actually under 3 months and 16 days, "4 to 6 months" is from 3 months and 16 days to 6 months and 15 days, inclusive, and so on.

Because of the rarity of rickets in Puerto Rico, the case histories of the five children showing roentgen-ray evidence of the disease are given in detail in Appendix E (p. 120) and are summarized as follows:

Case 1.—S. M. was a 7-month-old, full-term male infant who was born in a cellar of one of the large stone tenements of San Juan and had lived there until two weeks before examination. The apartment in which he lived had no outside window. At no time had he been taken out of doors. He had been fed practically from birth on a cow's milk mixture and had been given no cod-liver oil. There was a history of frequent attacks of bronchitis and daily convulsions for three or four months.

Physical examination showed broncho-pneumonia and evidences of severe rickets. Chvostek's sign was not elicited. Roentgenograms of the bones of the forearm (fig. 1) showed advanced rickets with a marked degree of osteoporosis. Blood studies showed a calcium content of 7.1 milligrams per 100 cubic centimeters of serum and a phosphorus content of 4.1 milligrams. A diagnosis of severe active rickets was made from the clinical and roentgen-ray examinations, and a diagnosis of tetany from the chemical examination of the blood. Figures 2 and 3 show the result of treatment with sunlight alone—Figure 2 at the end of 18 days, Figure 3 at the end of 3 months.

Case 2.—W. V. was a 5-month-old, full-term male infant who was taken out of doors very little—about half an hour a day—in the shade. He was on a mixed feeding of breast milk and condensed milk.

Physical examination showed slightly enlarged costochondral junctions, on the basis of which a clinical diagnosis of questionable rickets was made. The roentgenogram showed evidence of slight rickets with a slight degree of osteoporosis.

Case 3.—J. L. was a 5-month-old, full-term female infant, entirely breast fed. Physical examination showed none of the signs of rickets. The roentgenogram showed evidence of very slight rickets.

Case 4.—M. S. was a 3-month-old, full-term male infant, wholly breast fed. Physical examination showed a widely open fontanelle, a moderate degree of craniotabes, and slightly enlarged costochondral junctions. A clinical diagnosis of slight rickets was made. The roentgenogram showed very slight rickets.

Case 5.—M. G. was a 25-month-old, full-term female infant who was born in New York City, where the first 21 months of her life were spent. Her diet was mixed. No cod-liver oil had ever been given. Physical examination showed slightly enlarged costochondral junctions and slight knock-knees, but the evidence
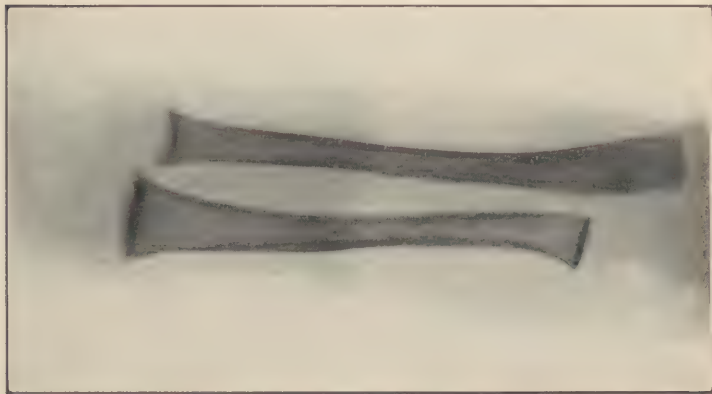
FIGURE 1.—Severe active rickets and osteoporosis in an infant (S. M., 7 months old) who had lived in a cellar in San Juan and had never been exposed to sunlight
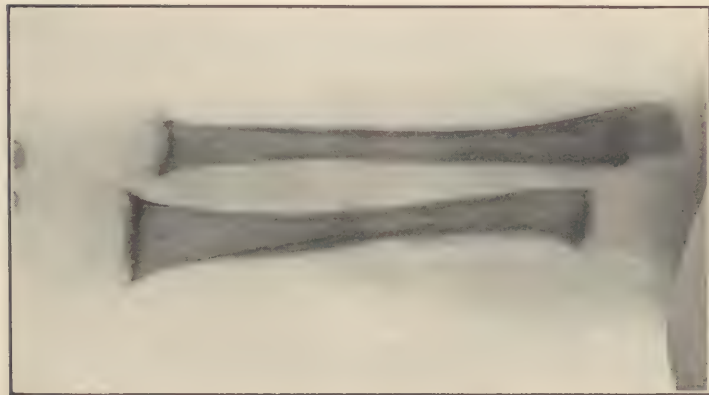
FIGURE 2.—Fresh lime-salt deposits in bones of same infant after 18 days' exposure to sunlight
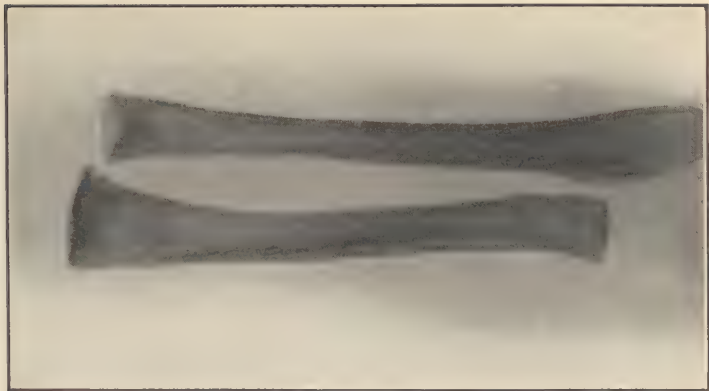
FIGURE 3.—Complete healing in bones of same infant after 3 months' exposure to sunlight

was not sufficient to make a clinical diagnosis of rickets. The roentgenogram showed evidence of old, healed rickets. Though this case is included in Table 10, it can not legitimately be counted as a case of rickets developing in the Tropics.

W. V., J. L., and M. S. (cases 2, 3, and 4) were all young infants who showed evidence of slight or very slight rickets by roentgen ray. The changes in their bones were comparable to those found in many infants in New Haven. It may be emphasized here that neither S. M. nor M. G. (cases 1 and 5) developed rickets under the influence of the usual environmental conditions of Puerto Rico—S. M., because the disease followed *complete* isolation of the infant from sunlight; M. G., because the disease undoubtedly developed while the child lived in New York City. J. L. and M. S. (cases 3 and 4) had apparently led the usual existence of young infants in Puerto Rico; W. V. (case 2) probably had been taken out of doors less than was customary.

Of the remaining 579 roentgenograms, 509 were classed as "normal" according to the New Haven criteria, and 70 for one reason or another were classed as doubtful. Detailed study of each of the doubtful roentgenograms has led to the belief that the findings that raised some question as to their interpretation were nearly all due to movement of the child's arm while the roentgenogram was being taken, to a position of the bones that allowed the epiphyseal surfaces to show more than was usual, or to improper roentgen-ray technique. The roentgenograms classed as doubtful, though tabulated separately in Table 10, in all probability should be thought of as showing normal bones.

The almost complete absence in Puerto Rico of the slight deviations from the normal commonly found in New Haven and diagnosed there as rickets lends great weight to the opinion that these deviations are in reality the earliest evidences of that disease. Though it is believed that their absence in Puerto Rico may be attributed primarily to the protective influence of the sunlight and their presence in New Haven to inadequate protection, nevertheless, the fact that the relatively slower growth of the Puerto Rican children may play some part must not be overlooked. Though the Puerto Rican children as a group were shorter and lighter in weight than white children of continental United States, as has been shown in Charts I and II, it has also been pointed out (pp. 21, 22) that the differences were comparatively slight in the first six months of life, the period when the bone changes most commonly made their appearance in New Haven children. It may be supposed, therefore, that many more than three Puerto Rican children would have shown changes similar to those found in New Haven children, had these changes been due to physiological growth alone. Slower growth was probably a minor factor in the prevention of the changes interpreted as rickets, as compared with the intense sunlight.

Age incidence.

The ages of the children at the time of examination are shown in Table 10. It will be seen that 3 of the 5 children showing rickets were under 7 months of age, and that 1, the child with severe rickets, was between 7 and 9 months. The child with a moderate healed process was over 2 years of age; and since the active stage of the disease must have occurred when the child was in New York, the case, as has been pointed out, should not be classed as rickets developing in Puerto

Rico. Of the 246 Puerto Rican children 9 months of age or under at the time of examination, only 4 (less than 2 per cent) showed roentgenographic evidence of rickets, whereas in a group of 407 New Haven children of the same age who had been given no treatment to prevent rickets 142 (35 per cent) showed such evidence. Of the Puerto Rican children 10 to 15 months old, none showed roentgen-ray evidence of rickets, whereas 79 of 249 New Haven children of the same age group (32 per cent) showed such evidence of the disease.

INTERPRETATION OF CLINICAL DIAGNOSIS IN THE LIGHT OF ROENTGEN-RAY DIAGNOSIS

The proper interpretation of the clinical signs usually considered to be manifestations of rickets is of practical importance, since in most communities it is impossible to provide roentgen-ray or chemical examination for all children suspected at physical examination of having the disease. A clinical diagnosis of rickets when the disease is moderate or severe is relatively easy, and few mistakes are made; but the diagnosis of mild rickets is often difficult and is probably made on many children who have not had rickets. In the study made in Puerto Rico considerable doubt may be thrown on the correctness of the clinical diagnoses because of the discrepancy between the incidence of rickets as shown by roentgen-ray examination and that shown by clinical examination.

When attempting to interpret the results of the clinical examinations in the light of the roentgenographic examination of the radius and ulna alone it is necessary to bear in mind some of the facts regarding the development and course of the disease and the limitations of both types of examinations. It should be remembered that rickets makes its appearance first in the ribs and soon afterwards affects the other long bones at their more rapidly growing ends. Theoretically, then, roentgenograms of the ribs should provide one of the best means of making a very early diagnosis of rickets, but the technical difficulties of obtaining satisfactory roentgenograms of the costochondral junctions make the use of this method virtually impossible. The roentgenographic method of diagnosis is, moreover, not delicate enough to reveal the truly incipient changes due to rickets, and it is not until the process has progressed to the stage at which the changes in the ulna are sufficient to cast a shadow that a diagnosis can be made by roentgenographic examination.

There is a brief period, then, of one or possibly two months at the beginning of the disease when roentgenography does not assist in the diagnosis of rickets. At this stage, too, the clinical evidences of the disease are usually indefinite and clinical diagnosis is unreliable. In certain cases of incipient rickets definite clinical evidence may, however, precede roentgen-ray evidence, as in the case of craniotabes[49], but more often clinical evidence accompanies the roentgen-ray evidence or follows it closely.

From the time that rickets is first seen in the roentgenogram of the ulna—usually at about the third or fourth month—and throughout

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[49] Though a slight enlargement of the costochondral junctions theoretically may be the earliest sign of rickets and may precede roentgen-ray evidence of the disease in the radius and ulna, the diagnosis of rickets on this basis in the absence of any other clinical signs of the disease has not been considered safe because of the great uncertainty of clinical judgment and the frequent errors made in the attempt to differentiate by palpation alone the costochondral junction that is normal from the one that is just over the border of the pathological. In a majority of cases in which enlargement of the costochondral junctions is sufficient for certain diagnosis, the roentgenogram also shows evidence of rickets in the radius and ulna.

the period of activity and healing of the disease, roentgenograms of
the bones of the forearm have their greatest value in confirming the
clinical diagnosis.   But when the disease has subsided and the process
of repair has wiped out the scars in the radius and ulna, roentgeno-
graphic examinations of these bones are no longer useful in judging
whether the clinical signs commonly thought of as signs of mild rickets
are, in individual cases, sequelae of the disease or normal variations
associated with growth.   Some light can be thrown on these later
clinical diagnoses by comparing their incidence with that of active or
healing rickets as shown by roentgenograms in earlier age periods.
As has been pointed out, the incidence of rickets found by roentgen
ray in the first year or two of life should form a background for the
incidence of rickets found by clinical examination either coinciden-
tally or later.   Since, moreover, the incidence of rickets found by
clinical examination at any given age level represents in general an
accumulation of current cases and cases that have occurred at one
time or another previous to the age in question, it is to be expected
that after the early months of infancy are passed the clinical incidence
of rickets would be higher than the maximum incidence found by
roentgen-ray examination at the same time or in any previous age
period.   This maximum incidence found by roentgen-ray examination
in a cross-section study must fall short of the true total incidence,
first, by the number of cases of incipient rickets not yet advanced
enough to show in the roentgenogram, and secondly, by the number
of cases of rickets that have already receded and hence no longer show
in the roentgenogram.   How much allowance should be made in
order to arrive at a true estimate of the total incidence of rickets is
not known.   If, however, a great disproportion exists between the
amount of rickets demonstrable by roentgen ray during the period
when the disease is usually active and the amount of rickets found
concurrently or later by clinical examination it is believed that this
disproportion probably represents a certain amount of error in clinical
diagnosis due to the difficulty of differentiating the clinical signs of
mild rickets from the variations of normal growth and development.

A roentgenogram may be expected, then, to help in confirming an
individual clinical diagnosis of rickets most often during the age of
greatest activity of the disease—roughly from 3 to 18 months.   After
this period is passed, and in many cases of mild rickets during the
latter half of it, roentgenograms may not help in the confirmation of
individual clinical diagnoses because the rachitic process has subsided,
leaving only the bony deformities on which the clinical diagnoses were
based.   When the incidence of rickets is being studied on a commun-
ity basis, however, the roentgenographic method of diagnosis gives
the most satisfactory picture of the total incidence of the disease
during the period when it is in its active stages and provides a basis
for interpretation of the clinical diagnoses made on the total group.

In an attempt to understand the great preponderance in Puerto
Rico of clinical diagnoses of rickets over those made by roentgen ray,
two methods of study have been used: First, a direct correlation of
the clinical with the roentgen-ray diagnosis made at the same time,
and, second, a comparison of the results of the two types of examina-
tion at different age levels.

Table 11 gives the clinical diagnoses made on 584 children and
shows whether or not they were corroborated by the roentgen-ray
diagnosis made coincidentally.   It will be seen that only two (4 per
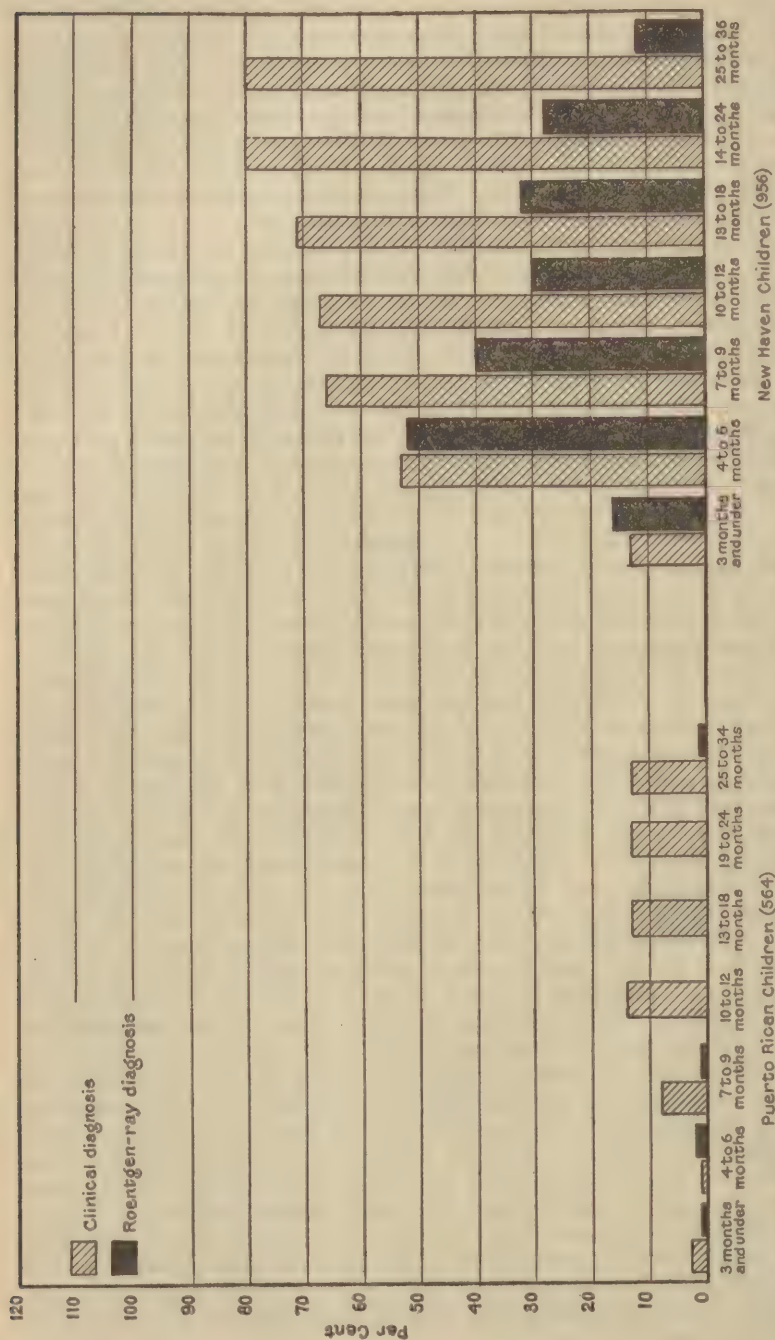
CHART VI.—Clinical and roentgenographic evidence of rickets at specified age periods in children examined in Puerto Rico and in children examined in New Haven who had been given no specific treatment to prevent rickets

cent) of the clinical diagnoses of rickets were corroborated by the roentgenograms. One of these diagnoses was of a case of marked clinical rickets in a child 7 months of age, the other a case of very slight rickets in a child 3 months of age. Both cases (cases 1 and 4) will be found discussed in detail in the case reports in Appendix E (p. 120). A similar correlation of clinical and roentgen-ray diagnoses was made for a group of 956 New Haven children of the same age group who had been given no specific antirachitic treatment, and it was found that 37 per cent of the clinical diagnoses of rickets were corroborated by roentgen-ray examination, a striking contrast to the Puerto Rico findings.

The relation between the incidence of rickets found by roentgen-ray examination and that found by clinical examination in different age periods is shown in Chart VI for 564 children examined in Puerto Rico and 956 children of a similar age group examined in New Haven. The contrast in the incidence of rickets (both clinical and roentgen ray) in the two communities is marked.

TABLE 11—*Clinical diagnosis of rickets in relation to roentgen-ray diagnosis; children examined in Puerto Rico*

Roentgen-ray diagnosis	Children examined											
	Total		No rickets		Clinical diagnosis of rickets							
					Question-able diagnosis		Rickets					
							Total		Very slight[1]	Slight[1]	Mod-er-ate[1]	Marked (1)
	Num-ber	Per cent dis-tribu-tion	Num-ber	Per cent dis-tribu-tion	Num-ber	Per cent dis-tribu-tion	Num-ber	Per cent dis-tribu-tion				
Total_____	584	100	400	100	134	100	50	100	13	33	3	1
No rickets_____	509	87	354	89	114	85	41	82	10	29	2	_____
Doubtful diagnosis_____	70	12	44	11	19	14	7	14	2	4	1	_____
Slight or very slight rickets_____	3	(2)	1	(2)	1	1	1	2	1	_____	_____	_____
Moderate healed rickets	1	(2)	1	(2)	.	_____	.	.	.	.	_____	_____
Marked active rickets__	1	(2)	_____	_____	_____	_____	1	2	_____	_____	_____	1

[1] Per cent distribution not shown as number of children was less than 50
[2] Less than 1 per cent.

If, however, the relation of one type of examination to the other is studied for the two groups considered separately and the results com-pared, it will be seen that in the Puerto Rican group the incidence of rickets found by roentgen-ray examination in the early age periods would seem to be far too small to account for the incidence found at clinical examination in the later age periods; whereas in the New Haven group, the incidence of rickets found by roentgen-ray exami-nation in corresponding early age periods is so large as to account very well for the proportion of the cases showing clinical evidences of rickets during the following years. The very small proportion of clinical diagnoses of rickets in Puerto Rico that were corroborated by

roentgen-ray examination, the discrepancy between the incidence of roentgen-ray manifestations in the early age periods and clinical manifestations in the later, and the almost complete absence of roentgenographic evidence of rickets at any age period strengthen the opinion that many of the clinical diagnoses were incorrectly made.

As has already been pointed out in the discussion of the clinical diagnoses, errors in the diagnosis of mild clinical rickets are probably made because of the difficulty of differentiating the skeletal changes due to mild rickets from those which are the result of normal growth and development. How much such error in diagnosis may account for the excess of clinical diagnoses over roentgen-ray diagnoses in New Haven is not known; in Puerto Rico, however, in the face of the almost complete absence of roentgen-ray evidence of rickets, it would seem probable that a great majority of the clinical diagnoses of rickets were incorrect.

DETERMINATION OF AMOUNT OF CALCIUM AND PHOSPHORUS IN THE BLOOD OF 34 SELECTED INFANTS

Chemical examination to determine the amount of calcium [50] and of inorganic phosphorus [51] in the blood serum was made for 34 infants, most of them 8 months of age or younger. Nineteen of the samples came from the group of infants for whom roentgenograms showed unquestionably normal bones, 9 from the group for whom roentgenograms showed bones which were probably normal but which for one reason or another were classified as doubtful, 5 from the group for whom roentgenograms showed severe osteoporosis or atrophy of the bones, and 1 from the infant with marked rickets. Unfortunately it was not possible to obtain samples of blood from any one of the three infants who showed slight or very slight roentgenographic evidence of rickets.

The findings on these samples of blood, as well as some clinical and roentgenographic data regarding the infants from whom they were taken are given on pages 54–55.

There are not enough cases to warrant drawing any definite conclusions with regard to the relation between the blood findings and the child's diet or his nutritional condition. It is of interest to observe, however, that of the 32 samples of blood for which the calcium content was reported 15 contained 11 or more milligrams per 100 cubic centimeters of serum, 11 contained 10 to 10.9 milligrams, 5 contained 8 to 9.9 milligrams, and 1 (the blood of the infant with active rickets and tetany) contained only 7.1 milligrams. The great majority of the calcium findings fell in or above the upper range of what is usually considered normal—9 to 11 milligrams per 100 cubic centimeters of serum, the average amount being 10.6 milligrams.

Of the 34 samples of blood examined for inorganic phosphorus, 23 contained 5 or more milligrams per 100 cubic centimeters of serum (each of 3 samples containing 6.4 milligrams, the highest reading), 9 contained 4 to 4.9 milligrams, and 2 contained just less than 4 milligrams. Both of the last-mentioned samples of blood were from infants the roentgenograms of whose bones showed severe osteoporosis

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[50] Kramer, Benjamin, and Frederick F. Tisdall: A Simple Technique for the Determination of Calcium and Magnesium in Small Amounts of Serum. Journal of Biological Chemistry, vol. 47, no. 3, (August, 1921), p. 475.
[51] Briggs, A. P.: A Modification of the Bell-Doisy Phosphate Method. Journal of Biological Chemistry, vol. 53, no. 1 (July, 1922), p. 13.

but no evidence of rickets. The average amount of inorganic phosphorus was 5.2 milligrams per 100 cubic centimeters of serum.

The product obtained by multiplying the calcium content (in milligrams per 100 cubic centimeters of serum) by the phosphorus content, the criterion suggested by Howland and Kramer [52] for the differentiation of rachitic from nonrachitic blood, is also shown on pages 54–55. In the opinion of these authors any product falling below 40 indicates rickets. In 25 of the samples of blood examined, this product was more than 50; in 4, between 40 and 50; in 3, between 30 and 40; for the other 2 samples the product was not determined, as the calcium content was not reported. Of the 3 with product below 40, 1 was blood from the infant with active rickets and the other 2 were from infants with severe osteoporosis, but no evidence of rickets. The average product of the calcium content and the phosphorus content in these 34 samples of the blood of infants living in the Tropics was 56.2.

[52] Howland, John, M. D., and Benjamin Kramer, M. D.: Factors Concerned in the Calcification of Bone. Transactions of the American Pediatric Society, vol. 34, p. 204. Washington, 1922.

Case No.	Initials	Age in months	Calcium in blood (mg in 100 c c serum)	Phosphorus in blood (mg in 100 c c serum)	Product of Ca content and Ph content	Roentgen-ray diagnosis	Clinical diagnosis	Clinical signs of rickets present	General nutritional condition of child	Feeding	Calcium (gms) in mother's daily diet [1]
15	P. B.	3	10.2	5.5	56.10	Normal	No rickets	Slight pot-belly	Fair	Breast milk	0.497
104	G. F.	4	9.9	5.6	55.44	do	do	Muscle tone fair; relaxation	Poor	Dried milk	.325
50	D. F.	4	10.6	5.2	55.12	do	do		Good	Breast milk; cow's milk, 1 pint a day.	.760
11	R. D.	5	11.1	6.2	68.82	do	do		Fair	Cow's milk formula.	.168
175	L. V.	5	8.6	5.8	49.88	do	do	Flaring ribs: muscle tone fair.	do	Breast milk	.178
69	B. L.	6	14.1	6.4	90.24	do	Questionable	Slight costochondral junctions; moderate frontal bosses; head asymmetrical.	Good	Breast milk; malted milk.	.771
5	C. L.	6	12.3	5.6	68.88	do	No rickets	Slight Harrison's groove; slight flaring ribs.	Very good.	Breast milk	.482
72	R. N.	6	10.0	4.4	44.00	do	do	Head asymmetrical; muscle tone poor.	Poor.	Condensed milk and rice water.	.453
48	J. S.	6	11.1	6.4	71.04	do	do	Slight pot-belly; muscle tone poor.	do	Breast milk; cow's milk, dried or fresh.	.241
180	S. M.	6	10.0	5.5	55.00	do	do		Good.	Breast milk; cow's milk, 1 quart a day.	
63	M. B.	6	10.1	5.2	52.52	do	do		Poor.	Condensed milk.	.213
88	G. R.	8	11.3	5.5	58.76	do	do	Slight pot-belly; moderate knock-knees.	Good.	Breast milk	.046
54	J. A.	8	11.0	5.9	64.90	do	Questionable		do	Cow's milk formula.	.168
133	R. N.	9	10.8	5.0	54.00	do	No rickets.	Muscle tone fair; relaxation	Fair	Breast milk	.226
53	C. F.	9	10.9	4.8	52.32	do	Questionable.	Slight Harrison's groove, flaring ribs; slight pot-belly; muscle tone fair, relaxation.	do	Breast milk; cow's milk, ½ pint a day.	
62	M. B.	10	11.1	6.4	71.04	do	do	Moderate parietal bosses; flaring ribs; pot-belly.	do	Breast milk; cow's milk, 1¼ pints a day.	.214
102	O. G.	13	10.5	5.6	58.80	do	do	Slight Harrison's groove; pot-belly; flaring ribs; muscle tone poor, relaxation.	do	Breast milk chiefly; cow's milk formula and barley water.	.287
331	C. R.	15	8.3	5.2	43.16	do	do	Slight epiphyses at wrist; moderate pot-belly.	Good.	Breast milk; cow's milk, ½ pint a day in coffee.	.147
563	R. R.	15	11.0	5.6	61.60	do	No rickets	Slight pot-belly.	Fair	Breast milk	.446
245	G. A.	2	11.7	5.9	69.03	Doubtful	Questionable.	Slight costochondral junctions.	Good	Breast milk; condensed milk.	.372
259	H. M.	3	11.2	5.4	60.48	do	No rickets.		Very good.		
6	M. E.	4	11.8	5.6	66.08	do	Questionable.	Slight epiphyses at wrist.	do	Breast milk.	.431

No.	Initials					X-ray findings	Clinical findings	Physical findings	Nutrition	Foods[1]	
99	M. P.	4	10.2	5.1	52.02	...do...	No rickets...		Good.	Cow's milk formula.	.417
8	H. R.	5	11.6	4.5	52.20	...do...	do		do	Breast milk; cow's milk.	.283
46	R. G.	6	(²)	4.7	(²)	...do...	do		do	Breast milk.	.789
59	C. R.	6	10.1	4.1	41.41	...do...	do		do	...do...	.214
13	E. L.	7	(²)	4.7	(²)	...do...	do	Muscle tone fair, relaxation.	do	...do...	.314
43	F. D.	5	11.4	4.9	55.86	Doubtful; osteoporosis +.	Questionable...	Slight costochondral junctions; slight pot-belly; muscle tone fair, relaxation; flaring ribs.	Fair	...do...	.405
234	S. M.	7	7.1	4.3	30.53	Marked active rickets; osteoporosis +++.	Very marked rickets; tetany; pneumonia.	Moderate costochondral junctions: moderate epiphyses' moderate Harrison's groove; moderate bosses, frontal and parietal; slight craniotabes; moderate pot-belly; moderate ribs; muscle tone poor, marked relaxation.	...do...	Cow's milk formula.	.306
144	R. P.	16	8.7	3.6	31.32	No rickets, osteoporosis +++.	No rickets...	Flaring ribs; moderate pot-belly; muscle tone fair, marked relaxation.	Poor.	Cow's milk, 1 pint a day.	.173
89	A. F.	22	11.2	5.7	63.84	...do	Questionable	Moderate parietal bosses; moderate bowlegs; flaring ribs; moderate pot-belly; muscle tone poor, marked relaxation.	...do...	...do...	.218
279	N. P.	7	10.2	3.7	37.74	No rickets; osteoporosis +++.	No rickets...	Marked relaxation; muscle tone very poor.	Very poor.	Cow's milk formula.	.156
568	M. R.	24	9.45	5.6	52.92	...do...	do	Moderate parietal bosses, flaring ribs; moderate pot-belly; muscle tone poor, marked relaxation; slight funnel chest.	...do...	Breast milk; cow's milk.	------
184	M. G.	32	11.6	4.7	54.52	...do...	do	Moderate knock-knees; muscle tone poor, marked relaxation; slight pot-belly.	Fair	Cow's milk in coffee only.	.069

[1] Foods recorded for sample day. See p. 82 for method of estimation of amounts of calcium in mothers' diets and discussion of findings.
² Not reported

ADDITIONAL ROENTGENOGRAPHIC STUDIES OF THE RADIUS AND ULNA

In addition to the study of the incidence of rickets, special study was made of the roentgenograms to show the incidence of osteoporosis and of transverse lines in the radius and ulna. The frequent association in temperate climates of osteoporosis with rickets adds interest to the fact that osteoporosis was found to be present in a climate where rickets was found to be practically nonexistent. That an inadequate amount of calcium in the diet is the most probable etiological factor in the production of osteoporosis in these Puerto Rican children and that poor nutrition and irregular growth account for the high incidence of transverse lines will be brought out in the following discussion.

INCIDENCE OF OSTEOPOROSIS

The most striking pathological finding in the roentgenograms of the bones of the children examined in Puerto Rico was the presence of osteoporosis. Osteoporosis is a rarefaction of the bone tissues, which may be secondary either to decreased formation and increased resorption of bone tissue or, as is more common in temperate climates, to lack of calcification of newly formed bone tissue, as in rickets. It is believed that in this group of Puerto Rican children a great majority of cases of osteoporosis were due to decreased formation of bone tissue rather than to a lack of calcification of newly formed bone tissue, since in only two cases (S. M., case 1, and W. V., case 3) was the osteoporosis associated with rickets.

Roentgenograms of the bones of 59 children—approximately 10 per cent of the total group examined—showed osteoporosis—19 to a mild degree, 40 to a more severe degree. In many of the latter the osteoporosis was so marked that it was described as atrophy. Border-line cases were found in large numbers, but unless the rarefaction was definite a diagnosis of osteoporosis was not made.

Detailed study of the roentgenograms showed a general rarefaction or thinning throughout the cancellous bone tissue. (See figs. 4 and 5.) Though this rarefaction varied considerably in degree in the cases studied, in the majority of cases it was of moderate degree; in a few, very marked. With the exception of the two children with rickets, in every child studied the cortex of the shaft was thin and delicate, being in some instances not more than a millimeter in thickness and tapering off toward the ends of the shaft to the thinness of paper. The cortex, as well as being thin, usually appeared very dense and solidly calcified. In the children with rickets the cortex was rarefied but thicker than normal, appearing layered, as is usual with rachitic bones in which osteoid tissue laid down by the periosteum is not being calcified normally.

In nearly all the cases of atrophy the marrow cavity was relatively wide and long, encroaching upon the spongiosa. In some, the marrow cavity was nearly free from trabeculæ and the spongiosa so rarefied as to suggest the "ground-glass" appearance described by Pelkan as characteristic of the early stages of scurvy.[53] The presence in the

[53] Pelkan, K. F.: The Roentgenogram in Early Scurvy. American Journal of Diseases of Children, vol. 30, no. 2 (August, 1925), pp. 174–188.

A. H.   N. P.

FIGURE 4.—Osteoporosis in two children: A. H., 6 months old; and N. P., 7 months old
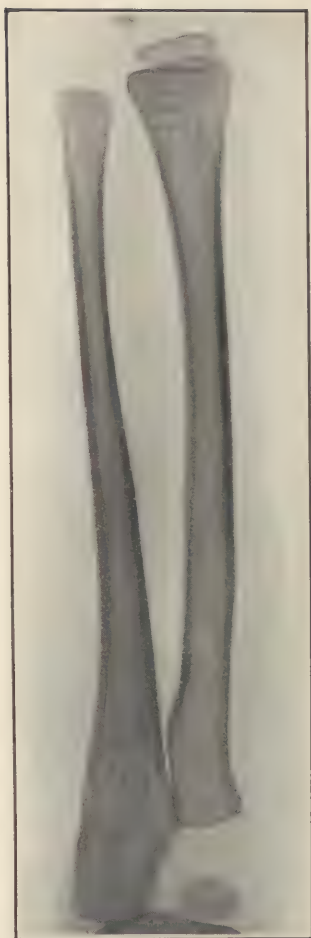
A. P.   M. G.

FIGURE 5.—Osteoporosis in two children: A. P., 34 months old; and M. G., 32 months old

spongiosa, however, of rarefied trabeculae or of poorly calcified trans-
verse trabeculae showing in the roentgenograms as transverse lines
differentiates this extreme rarefaction of atrophy from that of the
early stage of scurvy, in which usually no bony trabeculae are visible
in the marrow cavity. The absence of definite rings [54] around the
centers of ossification of the epiphyses, and the absence of any broad-
ening of the zone of calcification are further evidence that the rare-
faction was not of scorbutic origin. Occasionally fine penciled lines
were seen around the periphery of the centers of ossification in these
atrophic bones, which, though suggestive of rings, were too delicate to
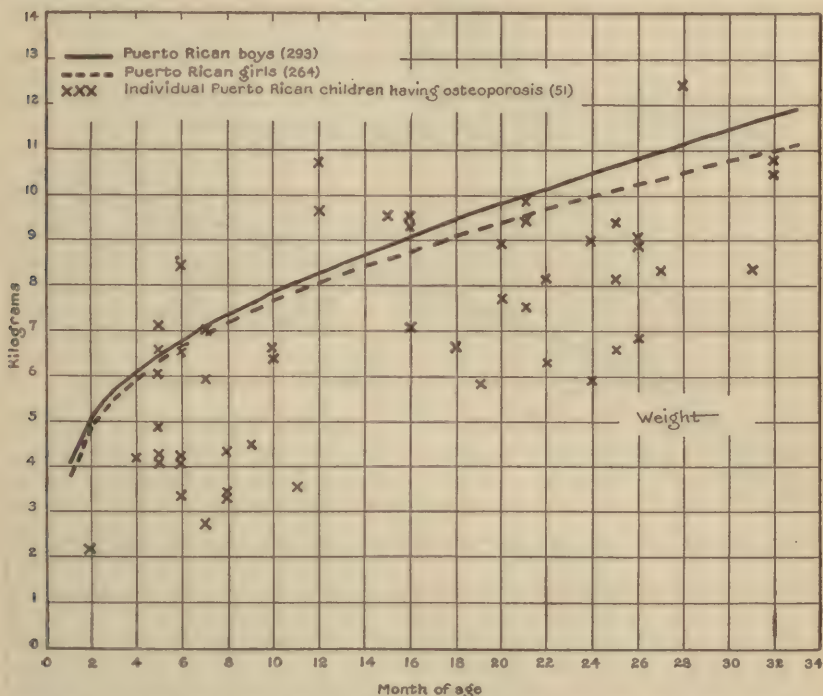
CHART VII.—Weights of individual Puerto Rican children having osteoporosis, compared with aver-
age weights of all boys and girls examined in Puerto Rico

be so interpreted. In some cases the spongiosa appeared to consist
of many very delicate trabeculae which cast but poor shadows; in the
most severe cases, described as atrophy, the trabeculae were relatively
few and very slender, forming a delicate tracery of lines parallel to the
long axis of the bone, or sometimes a coarse network, with the prin-
cipal lines running parallel to the long axis. In many of these atro-
phied bones transverse lines (figs. 4 and 5) were seen crossing the spon-
giosa at right angles to the long axis of the bone, indicating, as will be
pointed out, the frequent interruptions of growth that had taken
place.

The general physical condition of the children who showed this
osteoporosis of the bone was for the most part exceedingly poor, as

[54] Wimberger, Hans.: Zur Diagnose des Säuglingsskorbuts. Zeitschrift für Kinderheilkunde, vol. 36 (1923), pp. 279–285.

judged by the amount of subcutaneous fat found and by their weight
and height. More than half were markedly undernourished and some
were emaciated to an extreme degree. The weight and height of each
child with osteoporosis have been plotted on Charts VII and VIII,
according to the child's age at time of examination, to show the re-
lation of his weight and height to the average weight and height of
all the Puerto Rican boys or girls that were examined. The retar-
dation in growth of these children is striking.

The generally poor nutritional condition of these children and the
almost complete absence of rickets suggest that the rarefaction of the
bone tissue was due not to inability of the organism to calcify newly
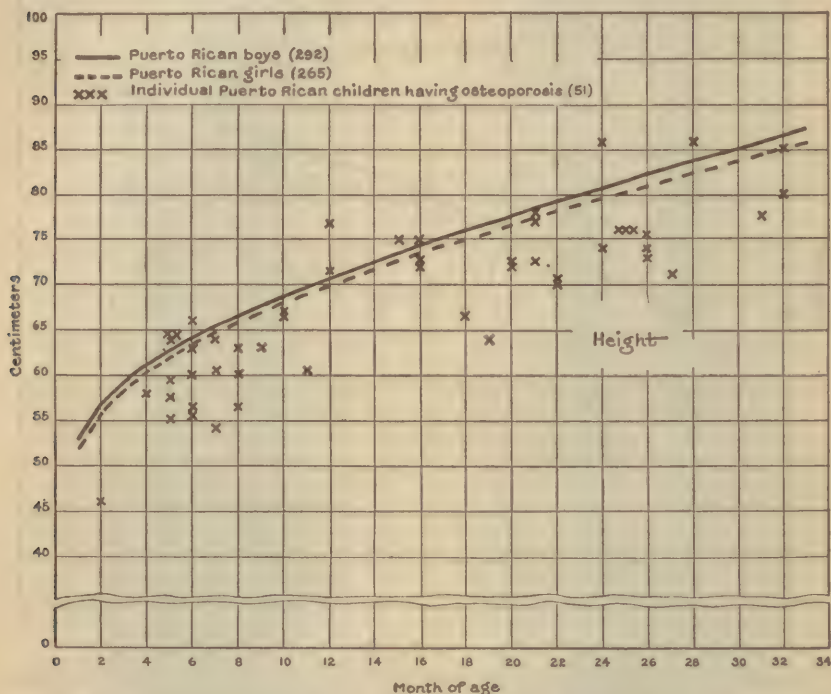
CHART VIII.—Heights of individual Puerto Rican children having osteoporosis, compared with aver-
age heights of all boys and girls examined in Puerto Rico

formed bone tissue, as in rickets, but to some profound nutritional
disturbance resulting in slow growth of bone with decreased deposi-
tion and increased resorption of lime salts. Whether the nutritional
disturbance bringing about this slow growth was due primarily to a
generally inadequate diet or to a major deficiency in calcium is not
known, but it is probable that a low calcium intake in the diets of the
Puerto Ricans (see p. 82) played a definite part in the production of
the osteoporosis described. Experimentally it has been shown that
diets deficient only in calcium result in osteoporosis of the bones.[55]
Osteoporosis or atrophy of the bones was described by Alwens[56] as

[55] Korenchevsky, V.: The Aetiology and Pathology of Rickets from an Experimental Point of View, pp.
53–73. Medical Research Council, Special Report Series No. 71. London, 1922.
[56] Alwens, Dr. [W.]: Über die Beziehungen der Unterernährung zur Osteoporose und Osteomalazie.
Münchener Medizinische Wochenschrift, vol. 66, no. 38 (Sept. 19, 1919), pp. 1071–1075.

occurring in adults as a result of starvation following the World War. The diets that he described were very similar to the Puerto Rican diets—they were lacking chiefly in calcium and protein containing foods, such as milk and milk products, green vegetables, fruit, and eggs. The roentgenographic appearance of the bones described by Alwens is apparently very like that found in this study.

So, too, the atrophy of the bones found in coeliac disease is apparently very similar to that here discussed. Parsons describes the roentgenographic appearance of the long bones in coeliac disease as follows:

> If the child be under 7 years of age there probably will not be any evidence of rickets, but the bones look unduly small, even allowing for the small stature of the child. The trabeculae may be well formed, but should the disease have been present for any length of time the trabeculae appear to be thinner and the whole bone more osteoporotic and fragile than normal. The cortex also is thinner than would be expected, but the epiphyseal line is quite sharp and distinct.[57]

Since in coeliac disease the growth of bone is greatly retarded, osteoporosis or atrophy results rather than rickets; but when improvement takes place and growth starts, rickets may be superimposed on the osteoporosis. In Puerto Rico slow growth of bone and adequate exposure to sunlight combine to prevent the development of rickets in these atrophic bones.

INCIDENCE OF TRANSVERSE LINES IN LONG BONES

The narrow transverse lines of dense bony tissue frequently seen crossing the spongiosa in roentgenograms of long bones are believed to be evidence of periodic or intermittent growth. Each line is the shadow cast by a thin plate or latticework of well-calcified trabeculae which has formed at the end of the bone at a time when growth of the bone in length has temporarily ceased. The anatomical condition responsible for these transverse lines in the roentgenograms has been described in the literature.[58][59] It is further believed that lines occur more frequently in older children and in those who have been chronically ill or have had some wasting disease. Though transverse lines may be found in roentgenograms of children with rickets, it is not believed that rickets is responsible for the formation of these lines except as it interferes with the growth of the bones.

Study of the roentgenograms made in Puerto Rico seemed to offer an interesting opportunity to observe the incidence of these transverse lines in a group of young children living under tropical conditions, a group in which many were retarded in physical development but practically none had rickets. The incidence of these lines in children examined at specified ages is shown in Table 12 both for the Puerto Rican group and the New Haven group. It is apparent that the proportion of children under 3 years of age showing transverse lines in their long bones is greater in Puerto Rico than in New Haven and that

[57] Parsons, Leonard G.: The Bone Changes Occurring in Renal and Coeliac Infantilism, and Their Relationship to Rickets. Part II. Coeliac Rickets. Archives of Disease in Childhood, vol. 2, no. 10 (August, 1927), p. 200.

[58] Eliot, Martha M., Susan P. Souther, and E. A. Park: Transverse Lines in X-Ray Plates of the Long Bones of Children. Bulletin of the Johns Hopkins Hospital, vol. 41, no. 6 December, 1927 , pp. 364-388.

[59] Asada, Tameyoshi: Über die Entstehung und pathologische Bedeutung der im Roentgenbild des Rohrenknochens am Diaphysenende zum Vorschein Kommenden parallelen Querlinienbildung. Mitteilungen aus der Medizinischen Fakultät der Kaiserlichen Kyushu-Universität, vol. 9, no. 1 (1924), pp. 43-95.

the difference occurs chiefly after the early months of infancy are passed.   Nearly half the Puerto Rican children more than 1 year of age showed lines.   In New Haven in no group of children under 3 years did so large a proportion show lines; but when children between 3 and 6 years of age were studied, it was found that 48 per cent showed lines. These findings are to be expected if interruptions in growth are the pathogenic factors.

Among the Puerto Rican children transverse lines occurred more frequently in children whose nutritional condition was poor.   In the group of 72 Puerto Rican children reported as being greatly under-nourished, 39 (more than one-half) showed transverse lines in their bones; of the 332 children who seemed to be well nourished, only one-fourth showed them.   It is also of interest that of the 59 children who had osteoporosis or atrophy of the bones, 42 (nearly three-fourths) showed transverse lines in their long bones, and of the 525 who were not classified as having osteoporosis less than one-third showed them. When malnutrition was so severe that osteoporosis developed in the bones, either interruptions in growth became more frequent or, because of the thin texture of the bone, the scars were more easily seen.

TABLE 12.—*Transverse lines in radius and ulna of children examined at specified age periods in Puerto Rico and in New Haven, Conn.*

Age [1] at examination	Children examined in Puerto Rico				Children examined in New Haven			
	Total	Lines present		Lines absent	Total	Lines present		Lines absent
		Number	Per cent			Number	Per cent	
Total	584	200	34	384	1,186	339	29	847
Under 8 months	196	34	17	162	288	58	20	230
8 to 13 months	146	51	35	95	296	54	18	242
14 to 34 months	222	105	47	117	348	105	30	243
35 to 60 months					254	122	48	132
Not reported	20	10	([2])	10				

[1] Age is given as of nearest month: that is, "under 8 months" is actually under 7 months and 16 days, "8 to 13 months" is from 7 months and 16 days to 13 months and 15 days, inclusive, and so on.
[2] Per cent not shown because number of children was less than 50.

SOCIO-ECONOMIC CONDITIONS AS FACTORS IN THE HEALTH OF PUERTO RICAN CHILDREN

Because of the influence that certain social and economic conditions have in temperate climates on the incidence and severity of rickets, special study was made of the environment of these children living in a tropical climate. That poverty and ignorance and the accompanying poor hygiene and inadequacy of diet contribute in temperate climates to the development of rickets in its severest forms is generally conceded, but that these factors are not primary in the causation of the disease is shown by the essentially complete absence of the disease in Puerto Rico, where, according to the data presented in the following sections, the people are very poor and the diets of the lowest quality.

Information on family groups, income, housing, and diet was sought in Puerto Rico, as in New Haven, primarily with the idea of demonstrating whether any relation exists between the socio-economic conditions and the presence of rickets, and secondarily as of interest in relation to the general health of the children studied. Since, as has been pointed out, no evidence of rickets was found in the vast majority of the Puerto Rican children examined, the absence of the disease under conditions that, in a colder and less sunny climate, contribute materially to its development in the severest forms, is extremely striking. The great amount of severe rickets reported among Puerto Rican children living in crowded tenements in the city of New York makes even more striking the absence of rickets in the children studied in Puerto Rico.

As has been pointed out earlier in this report, the children included in the study were brought for examination through the efforts of public-health nurses, and most of them had been brought previously by their mothers to the child-welfare conferences of the insular department of health. The data may be regarded, therefore, as characteristic of families that were intelligent enough to seek such health advice, probably representing the middle and lower economic groups of the people of Ponce and of San Juan and its outskirts. Of these two cities, San Juan not only is the larger but is the seat of the insular government and the port at which nearly all ships dock. In San Juan, therefore, there are greater opportunities for laborers and skilled artisans to find work, and, in general, as will be shown by the data on income, the people of San Juan are not so poor as the people of Ponce.

Home visits were made to 506 of the 534 families having children included in the study; 28 families could not be visited. Fifty of the families visited each had 2 children included in the study; the information collected through home visits, therefore, has to do with 556 of the 584 children examined.

SIZE AND COMPOSITION OF FAMILY AND OF HOUSEHOLD

The households in which these Puerto Rican children were living varied considerably in membership. Besides households consisting of an ordinary family—mother, father, and their children—many

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households were visited that included various persons not members of the family [60]—children and adults, some relatives, some not. In many houses, because of economic pressure, two families had moved in together to form a single household. The houses were small, and the crowding was therefore great, as will be shown in the section on Housing (p. 69).

Households were visited also from which one or more members of the family were absent. A number of children were being cared for away from home because of the poverty of their own families, and a number of fathers were living away from home. Some of these customarily remained away for months at a time as the seasonal demand for labor arose in different parts of the island, and some because by local custom family ties are loose. Many of the marriages were consensual or common-law marriages; but though it is possible that some of the fathers did not feel full responsibility for supporting the family, in general such families were relatively stable units of society. The children of such marriages, though reported as illegitimate in the vital statistics, were considered legitimate in the social group to which they belonged and were accepted without question as members of the family.

Table 13 shows the size of the family of which the child under observation was a member and also shows whether or not the household in which he lived included persons other than members of this family. It will be seen that nearly one-half the families were composed of 3 or fewer persons living at home, about one-fifth of 4, and one-third of 5 or more. The size of the families ranged from 1 person (the child under observation, cared for away from home) to 15, the majority being composed of 3, 4, or 5 persons. The average number of persons in these families was 4. There was no difference on the whole in the size of the families in Ponce and in San Juan.

Of the 503 families for which information was obtained on this point Table 13 shows that 241 were living in the same household with another family or with some person or persons not members of their own families. As would be expected, the smaller families were more likely to take other persons to live with them in the same household than were the larger families. The number of persons in the household who were not members of the family of the child under observation varied considerably. Ninety-one households had but 1 member in addition to the family of the child under observation; 45 had 2; 41 had 3; and 64 had 4 or more.

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[60] The term "family," as used in this study, includes the child under observation, his mother, his full brothers and sisters and his maternal half-brothers and half-sisters living with him and his mother, and the man with whom the mother was living, whether they were legally married or not. Paternal half-brothers and half-sisters and other relatives are not considered members of the family even though they were living in the same household.

TABLE 13.— *Number in child's own family and presence in household of others than members of family; families visited in Puerto Rico*

Number in family	Families visited						
	Total		Group in household				
			Family only		Family and others		Group not reported
	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution	
Total	506	----------	262	----------	241	----------	3
Number reported	503	100	262	100	241	100	
1	4	1	----------	----------	4	2	----------
2	55	11	11	4	44	18	----------
3	178	35	98	37	80	33	----------
4	105	21	56	21	49	20	----------
5	71	14	40	15	31	13	----------
6	35	7	19	7	16	7	----------
7	29	6	19	7	10	4	----------
8	14	3	11	4	3	1	----------
9	6	1	4	2	2	1	----------
10 or more	6	1	4	2	2	1	----------
Number not reported	3	---------	---------	---------	---------	---------	3

FAMILY INCOME

Information was sought as to the total family income for the year preceding the study for each family visited, the source of this income, the number of persons maintained on it,[61] the occupation of both father[62] and mother, and any period of unemployment of the father during the year. Effort was made to determine the relation of either the total or the per capita income to various socio-economic factors, such as housing, unemployment of the father, necessity for the mother's working, and adequacy of diet.

As it was not possible for the investigators to interview the fathers, the information on income and unemployment was obtained from the mothers at the home visits.

The total family incomes for the year preceding the study are shown in Table 14. It will be seen that almost half the families studied were existing on incomes of less than $400 a year and that only 10 per cent had incomes of $1,000 a year or more. Of the 39 families that had an income of $1,000 or more, only 7 had $2,000 or more. Many families with very low incomes might be cited; as, for example, a mother and child who had a total income of less than $50 for the year and two families of 3 persons each, existing on $75 a year for each family. Each of 14 families reported a total annual income of less than $100. These figures represent estimates of the income in money only; any assistance in the form of food, clothing, and shelter that may have been given by friends or relatives is not recorded. A

[61] The "income group" consisted of the persons who were supported by the total family income, whether they were living in the household as members of the family or boarders or whether they were living away from home.

[62] For the purpose of this study the term "father" is used to designate the man with whom the mother was living, whether or not she was married to him and whether or not he was the father of the child under observation.

great majority of the families studied were exceedingly poor. The relative smallness of the incomes reported may be judged by the fact that food prices in Puerto Rico for staple supplies such as rice and beans were about the same as in continental United States, but it should be noted that rents were a small item in the budget, that the problem of heat for the house did not exist, and that little was spent for clothing.

Table 14 also brings out the fact that incomes in Ponce were significantly smaller than those in San Juan. In Ponce 63 per cent of the families had incomes of less than $400 for the preceding year, whereas in San Juan only 41 per cent had similarly low incomes.

TABLE 14.— *Annual income of families visited in San Juan and in Ponce, P. R.*

Annual income [1]	Families visited					
	Total		San Juan		Ponce	
	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution
Total	506		328		178	
Amount reported	378	100	247	100	131	100
Less than $100	14	4	7	3	7	5
$100, less than $200	36	10	18	7	18	14
$200, less than $400	134	35	77	31	57	44
$400, less than $600	85	22	61	25	24	18
$600, less than $800	47	12	34	14	13	10
$800, less than $1,000	23	6	16	6	7	5
$1,000 or more	39	10	34	14	5	4
Amount not reported	128		81		47	

[1] Aggregate amount contributed to family support.

Table 15 shows the number of persons maintained on the incomes reported. Comparison of the incomes of the smaller families (four persons or fewer maintained) with those of the larger families (five persons or more maintained) shows that, though the smaller families tended to have slightly smaller incomes, on the whole incomes did not increase significantly with increase in number maintained. In other words, as would be expected, the larger the group maintained the smaller was the income per person and the less satisfactory the economic conditions in general.

TABLE 15.—*Annual income of family and number of persons maintained on this income; families visited in Puerto Rico*

Annual income [1]	Families visited					
	Total	Number maintained on family income				
		3 or fewer	4	5	6 or 7	8 or more	Not reported
Total	506	146	95	76	77	37	75
Less than $200	50	23	12	6	8		1
$200, less than $400	134	46	30	27	22	9	
$400, less than $600	85	23	23	18	13	8	
$600, less than $800	47	10	9	12	12	4	
$800, less than $1,000	23	7	5	4	5	2	
$1,000 or more	39	15	7	3	5	5	
Amount not reported	128	22	9	6	12	5	74

[1] Aggregate amount contributed to family support.

SOURCE OF INCOME

The source of income— that is, the persons who furnished it—was known for 498 of the 506 families visited. For 474 families it was also known whether the father or the mother or some other person was the chief support. In all but 24 of these families the mother or the father was the sole or the chief support. As will be seen in Table 16, in 399 families the father was the sole or chief support, and in 17 he contributed a smaller proportion to the income. In 51 families the mother was the sole or chief support, and in 120 she contributed a smaller proportion to the income.

Of the 506 families that were visited only about three-fourths (378) reported their total annual incomes. Of these all but 1 reported also the source of income. Among the 377 families whose incomes were reported and for whom source of income was known, it was plain that as a whole those whose sole or chief support was the father had greater incomes than those whose sole or chief support was the mother or some other person. Of the 332 families whose income was known and who were supported solely or chiefly by the father, more than one-half had total annual incomes of $400 or more; of the 45 families supported solely or chiefly by the mother or some other person less than one-third had incomes of $400 or more.

TABLE 16. *Persons contributing to family support and person furnishing chief support; families visited in Puerto Rico*

Persons contributing to family support	Families visited				
	Total	Person furnishing chief support			
		Father	Mother	Other [1]	Not reported
Total	506	399	51	24	32
Father only	258	258			
Father and mother	116	97	9		10
Father and other	37	30		3	4
Father, mother, and other	20	14	2	3	1
Mother only	16		16		
Mother and other	39		24	6	9
Other only [1]	12			12	
Not reported	8				8

[1] Includes relatives and outside agencies.

EMPLOYMENT AND WAGES

Because of the fact that most of the children examined in this study lived in cities, it is not surprising to find that very few of the fathers were employed in the leading industries of the island, namely, the raising of sugar, tobacco, coffee, and fruit. A large proportion of the fathers were engaged as skilled or semiskilled workers or as laborers in manufacturing and mechanical industries or in transportation. Others were employed in various branches of trade or in public or domestic service; a few were employed in clerical positions.

Wages were low, there was an oversupply of laborers, and they had long periods of unemployment. Wages for men working in the fields varied from 25 cents a day to $1.25.[63] In the cities wages were a little higher. Many jobs, however, because of seasonal or other periodic

[63] For average daily earnings in various industries see Puerto Rico; what it produces and what it buys, p. 11 (Trade Information Bulletin No. 785, Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce, Washington, 1932).

variations, provided a relatively small amount of work during the year; and many, though lasting the year around, provided only two, three, or four days' work a week.

In addition, because of the long-continued habit of subsisting on an extremely small income, many of the men voluntarily worked only a few days a week. The oversupply of laborers, their general lack of physical vigor—for which hookworm, malaria, and inadequate diet were probably largely responsible—and their lack of knowledge of any mode of life other than that providing the barest subsistence were probably the underlying causes of this intermittency of work. The poor physical condition of the average laborer was alone enough to account for his lack of ambition for a steady job. He was usually satisfied with just enough to provide the traditional rice, beans, and coffee for his family.

The women of the family frequently attempted to supplement the income derived from the men's wages, but they were even more underpaid than the men. In the fields and factories women might receive as little as 40 to 50 cents a day, and for home needlework the pay was often less. A minimum-wage law attempted to meet the problem of low wages for factory workers. It did not, however, meet the problem of handwork done in the home. Many women who had to stay at home to care for children spent long hours at embroidery or other forms of needlework, earning $1.25 to $2 a week. Consequently, even the mothers who worked steadily could add but little to the family income. As a rule, the mother who worked probably earned $25 to $100 a year. Some earned as little as $10 a year, others as much as $200 or $300. Since it often happened that the mother worked when the father was unemployed, the income of a family to which the mother as well as the father was reported to be contributing might not be very different from the income to which the father alone contributed. Other members of the family sometimes added a little to the family income; but since they had to meet the same labor conditions as the father and the mother, the amount they were able to contribute was usually small. The majority of the women who were employed were engaged in domestic labor or in sewing.

UNEMPLOYMENT OF FATHER

The income was low in many families, partly because the father was unemployed much of the time. The duration of the father's unemployment, the total annual income, and the source of the income are known for 334 families. For these families it was reported that 140 of the fathers (42 per cent) had been unemployed for varying periods of time during the past year—42 fathers for less than 3 months; 51 for 3 to 5 months; 38 for 6 to 8 months; and 9 for 9 months or more. The figures for duration of unemployment include both long periods of unemployment at a single stretch and the estimated aggregate of unemployment of men employed regularly but for part of the time only.

Table 17 shows the duration of unemployment of the father and also the annual income for the 334 families for which the data with regard to unemployment and income were known. Of the 194 families in which the father was regularly employed, the total income fell below $400 in only 62 families (32 per cent); whereas of the 140

families in which the father was unemployed for various lengths of time, 86 families (61 per cent) had incomes below $400.

TABLE 17.—*Annual income of family in relation to the father's unemployment; families visited in Puerto Rico*

Annual income[1]	Families visited							
	Total	Unemployment of father						Father dead, not living with family, or not contributing
		None	Less than 3 months	3 months, less than 6	6 months, less than 9	9 months or more	Not reported	
Total	506	230	46	57	50	14	54	55
Less than $200	50	6	2	6	16	1	6	13
$200, less than $400	134	56	11	26	17	7	13	4
$400, less than $600	85	45	17	15	4	1	1	2
$600, less than $800	47	40	5	2				
$800, less than $1,000	23	17	3	1	1			1
$1,000 or more	39	30	4	1			2	2
Amount not reported	128	36	4	6	12	5	32	33

[1] Aggregate amount contributed to family support.

FAMILY INCOME IN RELATION TO DIET

The relation of the total family income to the use of various essential articles of diet, such as milk, butter, eggs, and green vegetables, will be discussed in the section on Family diets (p. 78). Suffice it to say here that, as would be expected, a definite association was found between the size of the family income and the frequency with which the essential foods were eaten by the family. There would seem to be little doubt that if the families were to receive an adequate income and some further education, the quality of the Puerto Rican diets would rapidly improve.

PER CAPITA INCOME

As the per capita income for the year takes into consideration not only the family's annual income but also the number of persons maintained by it, a better picture of the amount of money available to support an individual over a year's time is given by per capita income than by family income. In the study of such factors as the mother's diet and the child's physical condition, therefore, the per capita income is used instead of the family income. Since it has already been shown that the total annual family incomes did not vary significantly with the number of persons maintained, it is obvious that the per capita income was considerably smaller in the larger families and larger in the smaller families. Table 18 shows this relation.

Some of the per capita incomes were found to be extraordinarily small. In 12 families, varying in size from 3 to 14 members, the per capita income was less than $25 a year. There is no reason to believe that these figures are not approximately correct. Persistent effort was made to get all the information possible regarding incomes, the incredible smallness of the figures acting as a stimulus to the investigators.

TABLE 18.—*Annual per capita income and number of persons maintained on annual income; families visited in Puerto Rico*

Annual per capita income [1]	Total		Number maintained on annual income [1]									
	Num-ber	Per cent dis-tribu-tion	3 or less		4		5		6 or 7		8 or more [2]	Not re-port-ed
			Num-ber	Per cent dis-tribu-tion	Num-ber	Per cent dis-tribu-tion	Num-ber	Per cent dis-tribu-tion	Num-ber	Per cent dis-tribu-tion		
Total.............	506	......	146	......	95	......	76	......	77	......	37	75
Income reported...........	377	100	124	100	86	100	70	100	65	100	32	......
Less than $50..........	66	18	10	8	12	14	13	19	21	32	10	......
$50, less than $100.....	130	34	33	27	30	35	28	40	26	40	13	......
$100, less than $150....	91	24	27	22	23	27	20	29	14	22	7	......
$150, less than $200....	38	10	21	17	9	10	6	9	1	2	1	......
$200 or more...........	52	14	33	27	12	14	3	4	3	5	1	......
Income not reported.......	129	......	22	......	9	......	6	......	12	......	5	75

[1] Aggregate amount contributed to family support.
[2] Per cent distribution not shown because number of families was less than 50.

Per capita income and diet of mother.

The relation of the per capita income to the quality of the mother's diet will be discussed in a later section (p. 88). Similar study of the relation of the per capita income to the child's diet proved to be not feasible, as at the time of the study the number of children who had been weaned and were, therefore, dependent on the family budget for their food was too small.

Per capita income and physical condition of children.

The physical status of the children, as judged clinically by the amount of subcutaneous fat, varied with the per capita income of the families to which they belonged, when the group of relatively well-nourished children was compared with the group of poorly nourished ones. Of 247 children with amounts of subcutaneous fat estimated as "very good" or "good," 122 (49 per cent) were in families with a per capita income of less than $100 a year, whereas of 51 children with subcutaneous fat estimated as "poor" or "very poor," 35 (69 per cent) came from families with similarly low incomes. As the group of children with "poor" amounts of subcutaneous fat is small, the difference in the proportions is probably not great enough to be considered definitely significant, but this finding certainly suggests that low incomes had a direct bearing on the poor physical condition of many of these children. That such a large proportion of children (49 per cent) who showed what was estimated to be a "good" grade of subcutaneous fat should be found in families in which the per capita income fell in the lower group is surprising until it is remembered that the standards for estimating amounts of subcutaneous fat were in all probability lowered to fit the group in Puerto Rico, and that the "good" grades of subcutaneous fat should be thought of as "fair" according to usual standards in continental United States, and the "fair" grade as poor.

HOUSING

Interest in the housing conditions of the families included in this investigation was centered in the amount of crowding in the house and in the possibility of exposure of the children to sunlight, both in the houses and out of doors in the yard or patio.

CROWDING

The degree of crowding in these Puerto Rican households is shown by the relation between the number of rooms in the house or apartment and the total number of persons occupying them. (Since the kitchen in some houses was part of the house and in others was in a shed or in the patio, it has not been counted in the number of rooms used by the household.) From Table 19 it is seen that in 98 households of 5 to 6 members each and in 54 of 7 to 10 members each the members of the household were crowded together in one or two rooms; one household of 11 members had only two rooms. This crowding is especially serious in consideration of the size of the rooms, usually about 8 to 10 feet by 10 to 14 feet. In connection with this crowding it should be remembered that the risk of transmission of communicable disease is very greatly increased by such close contact. It is not surprising that tuberculosis, when once introduced into such a household, spreads rapidly.

Table 20 shows the relation between the number of rooms occupied by the household and the presence in the household of persons other than members of the family. That nearly one-third of the households living in one room and two-fifths of those living in two rooms included some person or persons other than the members of the child's family is striking evidence of the economic pressure under which these families were living.

TABLE 19. *Number of persons in household and number of rooms (exclusive of kitchen) occupied by household: families visited in Puerto Rico*

Number in household	Families visited					
	Total	Number of rooms occupied by household				
		1	2	3	4 or more	Not reported
Total	506	165	172	86	76	7
2	11	7	3	1		
3	110	61	35	8	6	
4	92	37	41	9	5	
5	89	21	40	16	11	1
6	55	18	19	12	5	1
7	60	8	17	16	17	2
8	35	4	11	7	13	
9	19	3	4	4	8	
10	17	6	1	7	3	
11	5		1	2	2	
12 or more	10			4	6	
Not reported	3					3

TABLE 20.—*Number of rooms (exclusive of kitchen) occupied by household and presence in household of others than members of child's own family; families visited in Puerto Rico*

Number of rooms	Families visited						
	Total	Group in household					
		Group reported	Family only		Family and others		Group not reported
			Number	Per cent	Number	Per cent	
Total_____	506	503	262	52	241	48	3
1_____	165	165	116	70	49	30	_____
2_____	172	172	101	59	71	41	_____
3_____	86	86	26	30	60	70	_____
4 or more_____	76	76	19	25	57	75	_____
Not reported_____	7	4	_____	_____	4	_____	3

FURNISHINGS

Not only did the families lack the household water supply and sanitary conveniences usual in cities and towns in continental United States, but their homes were bare of the household furnishings and utensils that are ordinarily considered essential. A few families had beds, but the majority of the houses that were visited had only canvas or rope hammocks that could be taken down and put aside during the day. In the city dwellings and in some of the larger frame cottages chairs were found occasionally. Nearly every house had a small table or a built-in shelf that could be used as a table, and most of the houses had a small charcoal stove on which all the family cooking was done and on which the water for washing clothes and the flatirons were heated. In the poorer families tin cans were used as cooking utensils or even as a substitute for the stove itself.

EXPOSURE TO SUNLIGHT

The majority of the families included in the study lived in the largest cities on the island, San Juan and Ponce, and some lived on the outskirts of San Juan. The children in Ponce had much better opportunities to get sunlight than did the children of San Juan and its outskirts. The types of houses varied considerably in the different sections of the cities, but they had one characteristic in common, namely, a complete absence of window glass. The great majority of the houses were provided with latticed shutters for windows and doors; and as these doors and windows were almost invariably open except in stormy weather, sunlight entered most of the houses or apartments at some time during the day. A few apartments, mostly in the tenements of San Juan, admitted no sunlight at any time. These will be discussed later. More than four-fifths of the dwellings investigated had direct access to a yard or patio where much of the family housework was done and where the children could play. Such yard space was sometimes inclosed within a large building as a court, or between two buildings, or, as in the suburbs or *barrios*, it was frequently a small plot of ground surrounded by several frame houses or huts. Of the dwellings reported to have no patio or yard, a majority were either huts crowded together or city tenements.

Types of houses in relation to sunlight

The houses in which the families lived varied in type considerably with their location. In the city of San Juan proper, the most characteristic dwellings were the tenements; some of these had been converted from old Spanish buildings and some had been built recently. In the better suburbs of San Juan, such as Santurce and Barrio Obrero, small frame houses and *ranchons*, or row houses, predominated. In the poorer districts on the outskirts of San Juan, such as La Perla, Puerta de Tierra, Tras Tallieres, and the swamp district, the houses were largely huts or shacks, hastily and poorly constructed. In Ponce the majority of the houses were either small frame houses or huts. These are more characteristic of the usual Puerto Rican dwelling than are the tenements of San Juan.

Of the 556 children whose homes were visited, 113 (20 per cent) lived in the tenements of San Juan proper, 144 (26 per cent) lived in frame houses or *ranchons* in the suburbs of San Juan, 104 (19 per cent) lived in huts in the poorest districts on the outskirts of the city, and 190 (34 per cent) lived in Ponce, where the characteristic dwelling was a small frame house or hut. For five children living in San Juan the district in which they lived was not reported.

San Juan proper.—The tenements of San Juan proper were of four kinds. One kind consisted of tenements converted from old Spanish private dwellings. Most of these were two or three stories high; and, as they were ordinarily surrounded by similar high buildings, the patios, which were either in the center of the house or next to the wall of an adjoining building, were small and in a few cases completely shaded. Frequently there was an overhanging balcony around the patio on two or three sides, so that the rooms below were much darker than those above. In some of these tenements the patio was sunny for three to four hours during the day; in others the patio as well as the lower apartments received only reflected sunlight. There were many apartments in each of these houses. A few of these apartments did not open to the outside and were dark, with the exception of those on the top floor, which had skylights. This type of house had less sunshine than any other.

A second kind consisted of converted public buildings, such as monasteries or palaces. These were usually two stories high, built of stone, with stone floors in the rooms and patios. The original large rooms had been divided by low, thin partitions into apartments, the larger rooms being turned into three or four apartments, the smaller ones into one or two. These apartments usually had one to three small rooms, each room being about 8 to 10 by 10 to 14 feet in size. Frequently one room opened on a patio or balcony, and another on the street. Those apartments having three rooms usually had a center room with no opening to the outside except through the other two rooms. Since the two end rooms were small and usually sunny during some part of each day, these center rooms were, as a rule, not totally dark. Some of the buildings, however, had basement apartments that were totally dark, having no window nor door opening to the outside.

The third kind of tenement, which, on the whole, had more sun than either of the kinds previously described, was built on the side of a hill, with a series of patios on different levels or with a patio on the ground floor and receding balconies on the upper floors. The apartments in the buildings had one to four rooms, usually with at least one opening on a sunny patio or balcony. In some of these buildings

there were dark apartments that opened only on a hall; but, even if the sun did not actually enter the house, there was opportunity for the occupants to have easy access to sunshine for several hours each day.

The fourth kind, recently built and few in number, was constructed so that sunlight entered all apartments and was easily available in the patios. Such buildings were one to two stories high, and each surrounded a good-sized, sunny patio. In many cases apartments of three or four rooms extended from the street to the patio, with an opening at each end. As the partitions between the rooms were usually low, considerable light reached the inner rooms from the door or windows that opened into the street or patio. The tenements that were placed on the three sides of the patio away from the street were divided into one and two room apartments, the front room of each opening on the patio. Usually the patio was large and the building low enough so that it was sunny nearly all day long. Moreover, most of these apartments had sun shining into one or more rooms for part of the day, so that on the whole they constituted the sunniest type of house in San Juan proper.

It should be pointed out in conclusion that a great majority of the apartments in all these tenements had access to a sunny patio or to the street and that only a few of the apartments themselves were totally dark.

Outskirts of San Juan.—Santurce, Barrio Obrero, Sunoco, and Rio Piedras were places on the outskirts of San Juan from which children were brought to be examined. The houses there were smaller than in the tenement districts and were in general of four types: Frame cottages, huts, *ranchons*, and 2-story houses.

The majority of the people in these places lived in little frame cottages that were constantly exposed to sunlight. These houses had one, two, or four small rooms averaging about 8 feet by 10 feet in size. Usually there was a door opening from each room to the outside, and each house had two to four windows. The houses were raised from the ground on stilts, some only a few inches, others several feet. In Barrio Obrero and Rio Piedras the houses were arranged along streets, each house having its own yard. Some of the houses were shaded by trees, but the great majority were very sunny. In Sunoco and Santurce many of the houses were like those in Barrio Obrero. In some sections, however, they were not built along the streets but were grouped together irregularly with openings here and there resembling patios or yards. Occasionally the houses were fairly close together, with little or no yard space, but since they were low and small they were nearly all very sunny. A few small huts, similar to those in the swampy districts, to be described later, were found scattered among the other types of dwellings in Santurce.

Numerous *ranchons*, or rows of one-story houses, were found in Santurce. They varied somewhat in size and shape and were divided usually into apartments that were four rooms deep with a door at each end. The rooms were very small, so that light passed easily into the inner rooms. Despite the fact that these *ranchons* were often built close together, it was found that usually one room of each apartment was sunny for a part of each day. Most of them opened into a sunny yard, so that sun was easily accessible to anyone living in these houses.

In addition, there were a few small 2-story houses in Santurce. Some were occupied by one family, more by two families, and many by four or more families. As a rule, each family occupied one room. Most of these houses were sunny, but some of them that were built close together along the main streets were not sunny nor had they available sunny patios.

In the poorest districts on the outskirts of San Juan (La Perla and San Miguel, Puerta de Tierra, and Tras Tallieres), as well as along the edges of Santurce in the swampy region, the houses were, as a rule, the poorest type of hut or shack.

La Perla and San Miguel are two districts that extend down the cliff from the city wall to the edge of the sea. The hill is very steep, and many of the houses stand on high stilts on one side and are crowded together on the face of the cliff, without streets or sidewalks. The shacks usually had but one room about 10 feet square; they were constructed of all sorts of material, such as pieces of boxes or sheets of iron. Sometimes there was a window, with or without a shutter, but ordinarily the only opening was the door. If there was a second room it had, as a rule, no opening to the outside. In these huts one or more families lived, crowded together. There was no yard in which the children might play. The sanitation of these districts was very poor, few latrines were provided, and garbage and refuse were thrown out into the passageways between the shacks. However, both districts were sunny; and though there was little space where the children could play in the sun, they must have had the benefit of a considerable amount of the sunlight that entered the huts through doorways or windows.

Puerta de Tierra was divided into two parts. The upper part was dry and sunny, with little frame houses and a few 2-story tenements. In the lower swampy part, an open sewer ran down the middle of the street and overflowed under the houses when the tide was high. The huts resembled those in La Perla, except that they were perhaps even more dilapidated. They were all on stilts, and the ground under many of them was very wet. The huts were exposed constantly to sunlight, but there was no play space for children around them.

In Tras Tallieres and the swampy regions of Santurce the sanitary conditions were somewhat better, as there were no open sewers here. On the higher ground stood little frame houses, and on the lower, huts similar to those already described. Some of the houses stood on stilts over water and others were on little mounds surrounded by a ditch and marsh; these had to be approached by means of narrow plank walks over the swampy land. Many of the houses had no sunny play space about them, but the houses themselves were almost invariably sunny.

Ponce.—The types of houses found in Ponce were very similar to those found in the outlying districts of San Juan. There were a few blocks of 2-story buildings in the downtown section; but most of the people lived in small frame houses, in huts, or, occasionally, in 2-story houses, which were scattered over the plain and upon the hills with nothing to shade them. The ground upon which these houses were built was dry, and the sanitation was much better than in the poorer districts of San Juan. Nearly all the houses of Ponce had plenty of sunshine available within the house.

It is readily seen from this discussion of types of houses that with the exception of some of the worst of the tenement houses in San

Juan, practically all the Puerto Rican houses that were visited had some sunshine easily available either in the patio or in the house itself.

In the tenements of San Juan proper, where the apartments were dark, sunlight was usually available in the neighboring patios; in the huts of the swampy districts, where sunny play space was more or less lacking, sunlight was usually available inside the house or in the doorway or on a porch.

Availability of sunlight in houses and diagnosis of rickets.

Each of the houses studied was graded according to the approximate length of time that sunlight entered by either door or windows. At the time of year when the study was made, every house had both windows and doors open all day long, and most of the mothers stated that they closed them only when it rained hard or when it was very hot. Table 21 shows the length of time that the houses were reported to be sunny. A large proportion (512, or 92 per cent) of the children studied lived in houses that were sunny part of the day at least. About 65 per cent of the whole group lived in houses into which the sun shone through the open door or through unglazed windows for five or more hours a day. These were chiefly the frame houses or huts common in the suburbs and swamp districts of San Juan and in Ponce. One hundred and twenty-six children (23 per cent) lived in houses or apartments that had sun two to four hours a day. Most of the apartments were in *ranchons*, tenements, or 2-story houses, with the sunny doors or windows on one side only, so that the sun shone into the apartment only part of the day.

The 26 apartments that were sunny for less than two hours daily were nearly all in the tenements of San Juan. They had doors or windows opening under balconies or on patios surrounded by high buildings. In some of these houses the sunlight entered only for a few feet. Twenty-seven children lived in houses into which the sun did not shine at all but which were near a sunny patio or open space. A few of these houses were fairly dark, but as the sunlight was easily accessible, they were graded as slightly better than the 14 houses that not only were dark but also had no sunny yard nor patio. Three of these 14 latter houses opened into small, dark patios, 6 opened into narrow passageways, and 5 opened only into hallways.

TABLE 21 —*Children living in houses having estimated number of hours of sunlight a day; families visited in Puerto Rico*

Estimated number of hours a day of sunlight in house	Children in families visited	
	Number	Per cent distribution
Total	556	
Hours reported	553	100
5 hours or more	360	65
2 to 4 hours	126	23
Less than 2 hours	26	5
None in house, but sun easily accessible	27	5
None	14	3
Hours not reported	3	

The almost complete absence of roentgen-ray evidence of rickets goes to show that the amount of sunlight received was adequate to prevent the disease in nearly all the children. Moreover, it is obvious that there were too few cases of rickets to make it possible to draw any conclusions regarding the effect of the different amounts of sunlight that were available indoors. The fact that sunlight was available indoors as well as out is, however, probably of greater significance in the prevention of rickets among the infants, who spent a large proportion of their time in the house, than among the older children, who could go out by themselves. As has already been pointed out (see p. 46), only one infant showed severe rickets, and it is of interest to note here that this child lived in a house that received no sun at any time and that he was not taken out of doors at any time. The group of children for whom a clinical diagnosis of rickets was made is also too small to show what part was played in the diagnosis by the amount of sunlight available in the house.

The influence of the amount of sunlight available in the house on the prevention of rickets may be shown indirectly, however, through its relation to the presence of tanning of the skin, which is evidence of direct exposure to sunlight. A larger proportion of children who were tanned than of children who were not tanned lived in houses that were sunny for more than four hours each day or had a sunny yard available as play space.

DIETS OF PUERTO RICANS [64]

Poverty, local customs, and climatic conditions in Puerto Rico tend to limit the diet of the people. The basis of the diet was rice and dried beans, which, though largely imported, were the cheapest foods available. Tuberous vegetables and small amounts of meat or salt codfish were also used, and fruit in small quantities. There was not an adequate local supply of such foods as milk, butter, eggs, and fresh vegetables, which in continental United States are considered essential for the health of adults and for the health and normal growth of children, nor could the people as a rule afford to buy them. Besides, most of these families had no way to keep these perishable foods from day to day, and they had to buy them in small quantities if at all.

The diets of the families visited were unbelievably monotonous; there was very little variation from day to day and from family to family. The diets were poor in minerals, vitamins, and protein; many were low in caloric value also. The daily diet for the average family can be summarized as rice and beans twice a day—usually in large amounts, especially of rice; coffee twice or three times a day, with unrefined sugar and with or without a small amount of milk; bread in very small quantities, usually without butter; tuberous vegetables; and fruit in small quantities, the fruit chiefly for the children. Some families had nothing but rice and beans, and a few were found that did not even have both rice and beans every day.

The traditional dish of rice and beans was kept from being too monotonous by varying the method of cooking the rice, by using different types of beans (such as black beans, kidney beans, and navy beans), and by using peppers and spices for flavoring sauces made from the beans or by using olive oil on the rice in place of bean sauces.

Nearly all the families visited during the study—all except the very poorest—used some vegetables other than beans several times a week at least, as well as small amounts of meat or dried codfish. By use of these additional foods they added some vitamins and minerals to their diets, but not enough to bring the diets up to recognized standards. The additional foods were often served as stew or a cold dish similar to stew that was called "salad." A small amount of meat or salt codfish, rarely more than a quarter of a pound and often less, was customarily cooked with tuberous vegetables, such as white potatoes, sweet potatoes, or yautias, or with green platano (plantain), and sometimes with a small amount of tomato, cabbage, or beans. When such a stew or salad was served it was likely to take the place of rice and beans at one meal or to be served with rice in place of beans.

In many households enough rice and beans were prepared at noon to serve at both the noon and evening meals. The lack of cooking facilities made it impossible to have much variety of food at any meal.

[64] For further information on Puerto Rican diets see the series of bulletins entitled Tropical Foods, by Elsie Mae Willsey, published by the University of Puerto Rico, Rio Piedras. (First bulletin of series dated 1925.)

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As there were no facilities for storage of food or for refrigeration, only the staple supply of rice and beans could be kept on hand; all other foods—vegetables, meats, fruits, and milk—had to be bought, prepared, and eaten on the same day. In the market women were seen buying a part of a tomato, one onion, a few tuberous vegetables, or a few peppers as the daily supply for the family. Milk was often bought in very small quantities—even a cupful at a time—from street vendors. Milk for the baby may have been bought from a dairy.

The families who were better off than the average and who lived near enough to a market so that they could go there often were able to add more variety to their diets in the way of fruits and fresh green vegetables. Among the vegetables added were string beans, water cress, lettuce, cabbage, celery root, as well as gandules (pigeon peas), chayote (a vegetable resembling summer squash), and other vegetables grown on the island.

Fruits—oranges, bananas, mangoes, pineapples, and cherries— were used more or less regularly by a large proportion of the families, although the adults did not eat fruit so often as did the children. As there were no facilities for baking in the average home and as bakery food was both expensive and not easily available, bread and pastry were little used. Cereals, except rice, were used only occasionally. Raw sugar-cane was eaten as a sweet by both adults and children. Sweets other than sugar were used hardly at all. Granulated sugar, unrefined, was used freely in coffee, but not for other purposes.

Coffee was used customarily in all the households one or more times a day by the adults, and frequently by any or all of the children who were no longer breast fed. When a child was weaned, he was all too often given coffee, sometimes with milk, sometimes black. Most of the adults drank their coffee black, although some added a little milk.

Practically all the milk taken by the adults was the small amount that they put in their coffee. Though some milk was provided by many families for the children, relatively little was bought for the adults. Some families, who bought no fresh cow's milk, used small amounts of condensed, evaporated, or dried cow's milk, or of goat's milk.

The price of butter was so high as to be practically prohibitive. Eggs were used very little.

Detailed information was sought from the 506 families visited regarding the use of certain foods that in continental United States are considered necessary for an adequate diet. Estimates were obtained of the amount of milk used daily, the amount of butter and the number of eggs used weekly, and the number of times a week that meat or fish, fruit, leafy vegetables, and other vegetables were used. Effort was made to ascertain that the amounts reported were approximately those that were used customarily.

The data on these foods will be taken up under the following general divisions: (1) The diet of the family as a whole; (2) the diet of the mother of the family, with special emphasis on the food taken during periods of pregnancy and lactation; and (3) the diet of the child, as reported by the mother.

It should be borne in mind that nearly all the families studied lived in cities or on the outskirts of cities and therefore had easier access to markets than did many rural families, and that they were practically all families that were being taught by public-health nurses

to use such essential foods as milk and leafy vegetables. The diets of these families were probably better, therefore, than those of the average Puerto Rican family.

FAMILY DIETS

MILK

Information with regard to the purchase of milk was obtained from 487 of the 506 families visited. Only 10 of these families bought no milk at all; 15 bought fresh milk for the use of one special member of the family only, usually the youngest child or the mother; 393 bought fresh milk for the use of the whole family (both these groups were able to report with fair accuracy the quantity purchased daily); 69 bought canned milk, but reported the quantities so roughly that no attempt was made to record them.

Of the families who reported the quantity of fresh milk purchased, it will be seen that nearly two-fifths bought less than 1 liter [65] a day (as a rule about half a liter, or 1 pint). Nearly one-half the families bought 1 liter a day or a little more. Only about one-sixth bought as much as 2 liters a day. Considering the fact that each of these families averaged four members and that each included at least one child under 3 years of age, who should have had milk as the basis of his diet, or a child who was still breast fed and whose mother therefore should have been drinking milk freely, these quantities are small. Compared, however, with the per capita consumption of milk by the population of the island as a whole—namely, 1 to 2 ounces daily—these quantities seem relatively good and illustrate what could be accomplished educationally by the nursing staff of the department of health throughout the island if the supply of milk were greater and more easily available.

Families with incomes smaller than $400 yearly purchased considerably less milk than those with incomes of $400 or more. Less than one-half the families with the smaller incomes and more than three-fourths of those with the larger incomes bought a liter or more a day.

BUTTER

Butter was used in very small amounts by the majority of the families interviewed; 31 per cent of those reporting used no butter at all, 23 per cent used less than a quarter of a pound a week; 35 per cent, a quarter of a pound to a pound; and 12 per cent, 1 pound or more. No family used more than 3 pounds a week; and though in general the larger families used somewhat more butter, some of the largest, even those consisting of 10 or more members, used less than a quarter of a pound a week. On the whole, the families that used very little milk were the ones that used very little butter also.

As with milk, the poorer the family, the less butter was used. About two-thirds of the families whose total annual incomes were less than $400 each used no butter, or less than a quarter of a pound a week, and about one-third of the families whose incomes were $400 or more used similarly small amounts.

EGGS

Very few eggs were used by the families interviewed. Thirty-eight per cent of the familes reporting had used no eggs in the week before

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[65] A liter is approximately the equivalent of 1 quart.

the interview; 35 per cent had used not more than half a dozen; 18 per cent, half a dozen to 2 dozen; and 9 per cent, more than 2 dozen. As with milk and butter, the poorer the family the fewer eggs were used.

MEAT AND FISH

Meat, or more often dried codfish, was reported to have been used several times a week by all but four of the families interviewed; nearly half the families reported using it less than five times a week. In this connection it should remembered that meat and codfish were usually used in very small amounts, chiefly as flavoring in stews or salads. Rarely was more than a quarter of a pound used daily by the average family. The families with incomes of less than $400 were reported to use meat somewhat less frequently than those with larger incomes.

FRUIT

Fruit, chiefly citrus fruit, was used by the children in a large proportion of the families interviewed, only 9 per cent reporting that no fruit at all was used and 52 per cent reporting that fruit was used at least once a day. The families with incomes of less than $400 used fruit less frequently than did those with incomes of $400 or more.

VEGETABLES

Green vegetables, such as lettuce, water cress, spinach, cabbage, and string beans were little used by the families interviewed. Twenty-one per cent reported that they never used such vegetables; 36 per cent, that they used them once or twice a week; 24 per cent, three or four times a week; and 18 per cent, five or more times a week. Like the other articles of diet discussed, green vegetables were used more often by families whose incomes were $400 a year or more.

In addition to the inquiry on green vegetables, inquiry was made with regard to the use of other types of vegetables, including dried beans and root vegetables. Such vegetables were used very frequently and with rice formed the basis of the great majority of the diets. Only 7 per cent of the families interviewed reported using these vegetables less often than 7 times a week, 44 per cent used them from 7 to 10 times a week, and 49 per cent used them 11 or more times a week. As would be expected, these vegetables, which, together with rice, are the cheapest foods obtainable and have become by custom the basis of the diet of all Puerto Rican families, were used about as often by the families with incomes smaller than $400 a year as by those with incomes of $400 or more.

In general the family diets were found to be deficient in many of the foods considered essential to a diet for growing children and for pregnant or lactating mothers. Poverty seemed to be the chief cause of the inadequacy of these family diets. Larger amounts of milk, butter, and eggs were bought by the families with incomes of $400 or more a year than by those with incomes of less than $400 a year. Meat or fish, leafy vegetables, and fruit were used more frequently by the group with the better incomes; beans and tuberous vegetables about equally by the two groups.

The families visited in Ponce used less milk and butter, but considerably more beans and tuberous vegetables than did the families visited

in San Juan, who on the whole, had larger incomes. Apparently leafy vegetables, fruit, and small amounts of meat were used about equally in the two cities. Fewer of the families visited in Ponce than of those visited in San Juan used eggs.

DIETS OF MOTHERS

Information was sought regarding the diets of the mothers during periods of pregnancy and lactation, with the idea that study of the diets of those periods might throw some light on the general health of the mothers and children. As a basis for comparison with these diets information was sought also regarding the diets of the mothers when not pregnant or lactating. That the diets of the mothers were very poor at all the times studied will be shown in the discussion on pages 82–88.

Each mother was questioned as to the amounts and kinds of food she had eaten on the day before the interview and also whether this food differed from the food eaten during her recent pregnancy and, if so, in what respects. If she was not lactating, she was asked whether the food eaten on the day before the interview differed from the food eaten when she was lactating and in what respects it differed. Inquiry was made with regard to foods considered essential for good nutrition, emphasis being placed on those containing calcium, protein, and vitamins in largest amounts—milk, butter, eggs, meat, fruit, and leafy vegetables. Inquiry was also made with regard to the use of dried beans, tuberous vegetables, and rice and other cereals. The amounts of sugar and other sweets and of breadstuffs were not recorded, as at the time the data were gathered it was not intended to compute the caloric content of the diets.

Exact amounts of food taken by the mothers were not measured, but approximate amounts of foods eaten by the mothers were estimated from the total amount cooked for the family and the portions served to the members, the mother in particular. The information obtained from the mother regarding her diet was compared with that obtained for the diet of the family as a whole.

When inquiry was made concerning the foods eaten during periods of pregnancy and lactation, special emphasis was placed on changes in the amounts of milk, butter, eggs, fruits, and leafy vegetables.

The statements made by the mothers as to the amounts and types of food used were so much alike that the single day's diets, when considered together, probably give fairly accurate information on the usual diet of the Puerto Rican mothers with respect to the special items listed.

Diet histories for the day before the interview were obtained for 484 of the 506 mothers, 287 of whom were still nursing at the time of the interview, and 197 who were no longer nursing. As 50 of the 506 mothers each brought two children to be examined, and as many of them reported diets for the two pregnancies or the two periods of lactation, or both, the diets were recorded for each period of pregnancy and of lactation. Diets, therefore, were reported for 531 periods of pregnancy and for 505 periods of lactation. Of the 505 diets for periods of lactation, 287 were for periods not yet completed (that is, the mother was still nursing her child at the time of the interview), and in these cases the diet reported for the period of lactation is the same as the diet for the day before the interview; the remaining 218 diets were for lactation periods completed at varying lengths of time previous to the interview.

Before the discussion of the mothers' diet, a word should be said with regard to the general health of these women. No data were collected with regard to weight, but it was the impression of the examining physician that the women were in general poorly nourished. Most of them also were small in stature. As with the children, this may have been due partly to race and partly to prolonged underfeeding. The women of 25 or 30 years of age looked old and worn, and many of them were listless. Though most of them were well tanned, many showed pallor of the mucous membranes of the lips. It was estimated that the average mother probably weighed not more than 50 kilograms (110 pounds), and a weight of 50 kilograms has been used as the basis of computations concerning the diets.

In order that the diets might be compared with one another and with recognized standards and that relationship between the diets and such factors as family income might be studied, each diet had to be graded by a definite plan, according to its adequacy in certain food elements. In the course of two previous studies, one in Washington and one in New Haven, that had to do with the incidence of rickets, a plan for grading diets had been worked out that was based upon the foods usually eaten in continental United States. These diet grades were based primarily on the calcium and protein content of foods rather than on their caloric value.

Though the vitamin content of the diets was taken into consideration to some extent in planning the diet grades, no estimates on the vitamin content of individual diets have been made. It was soon found that the gradations planned for judging diets in continental United States were not suitable for judging the diets in Puerto Rico. The extreme poverty of the Puerto Rican diets necessitated an extension downward of the usual scale, so as to provide for the inclusion of diets that were poorer in calcium and protein than any found in continental United States.

ANALYSIS OF 112 SAMPLE DIETS

In order to determine the variation in certain constituents in the Puerto Rican diets, to be used in the preparation of the grading plan, a detailed study was made of a sample group of 112 mothers' diets. The cases included in this special study were taken at random from three groups of cases differentiated from one another only by the diagnosis made at roentgen-ray examination of the children's bones. Half the diets were those eaten by mothers of children showing entirely normal bones, a quarter, by mothers of children whose roentgenograms were considered somewhat doubtful (see p. 47), and a quarter, by mothers of children whose roentgenograms showed rarefaction or osteoporosis of such a degree that it was described as atrophy. The diets to be studied were selected at random within the groups described, those eaten by mothers of children with normal bones being selected in approximately equal numbers from the children in San Juan and Ponce. Of the diets so selected, 59 were those of mothers who were still lactating at the time of the interview and 53 of mothers no longer doing so.

It was believed that such a sampling would represent the variation of all the mothers' diets in calcium content and probably in other constituents, and that possibly some interesting facts might be brought out with regard to the relation between the mothers' diets and the development of the children's bones.

The approximate amounts of protein and of calcium in each of these 112 diets and also the number of calories were calculated from the data recorded with regard to certain foods eaten on the day before the interview. These will be found in Table 22.

TABLE 22.—*Caloric, protein, and calcium content of diets of 112 mothers* [1] *on day previous to interview and roentgen-ray diagnosis of condition of child's bones*

Roentgen-ray diagnosis of condition of child's bones	Total mothers	Calories			Protein (gms)			Calcium (gms)		
		Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum
Total	112	870	1,441	220	34.11	66.08	12.02	0.283	0.789	0.050
Normal	56	880	1,441	390	34.67	66.08	15.38	.286	.760	.072
Doubtful	28	890	1,318	357	34.62	51.51	12.18	.344	.789	.064
Osteoporotic	28	831	1,075	220	32.48	46.57	12.02	.217	.524	.050

[1] For foods recorded and for method of selecting these 112 mothers see pp. 80, 81.

Protein content.

The number of grams of protein in the food eaten by each mother on the day before the interview was estimated, and, as the amounts of practically all the protein-containing foods, except bread, were reported, it is likely that the estimates give a reasonably accurate picture of the protein content of these diets. The maximum number of grams of protein estimated for a single diet was 66, the minimum 12, and the average 34. According to Sherman,[66] who summarized data from 25 independent investigations, the average protein requirement is 44.4 grams per 70 kilograms of body weight per day, or 32 grams a day for a woman weighing 50 kilograms. Sherman further concluded from the studies that if only the *best* data were used (those which allowed a "reasonable period for adjustment to such a low protein diet"), the average requirement would probably be lower, or about 0.5 gram daily per kilogram of body weight. Using this latter figure, then, as more suitable for estimating the requirement for Puerto Rican women who are customarily on a low protein diet, it is found that for a person weighing 50 kilograms, the daily maintenance requirement would be 25 grams. The "standard" allowance recommended by Sherman—one that permits a reasonable margin of safety—is, however, 1 gram daily per kilogram of body weight,[67] or approximately 50 grams daily for a person weighing 50 kilograms. Such a standard is somewhat more than 50 per cent above the average requirement of 32 grams for a woman weighing 50 kilograms and is twice as much as the estimated requirement of 25 grams a day. The average number of grams of protein taken by the mothers in this sample group, then, was probably adequate for maintenance but was considerably below the standard and obviously did not provide the margin of safety permitted by such a standard allowance as that suggested by Sherman.

Calcium content.

The amount of calcium contained in the foods eaten by each mother the day before the interview was calculated; and since the quantity of milk, the chief calcium-containing food, had been obtained with the greatest care, and careful estimates had been made of other calcium-containing foods—vegetables, especially dried beans, and fruit—

[66] Sherman, Henry C.: Chemistry of Food and Nutrition, pp. 221–222. New York, 1932.
[67] Ibid., p. 511.

it is believed that the information regarding the calcium content of these diets is reasonably complete.

The maximum amount of calcium in any of these diets was found to be 0.79 gram, the minimum, 0.05 gram, and the average, 0.28 gram. This average falls slightly below the amount arrived at when the maintenance requirement as estimated by Sherman for a person weighing 70 kilograms, namely, 0.45 gram,[68] is adjusted to the needs of a person weighing 50 kilograms, namely, 0.32 gram. It should be borne in mind, moreover, that Sherman states that this maintenance requirement "approximates the minimum of actual need rather than a normal allowance," and that "the margin for safety should probably be at least as large for calcium as for protein."[69]

Sherman suggests that a 50 per cent increase above the average minimum requirement be allowed.[70] If this is done, so as to arrive at a "standard" allowance of calcium, it will be found that the average woman of this Puerto Rican group should have been receiving approximately 0.48 gram of calcium daily instead of what she actually received, namely, 0.28 gram. To provide for the increased demand for calcium during pregnancy or lactation, moreover, this standard allowance should again be liberally increased, probably until it approaches the amount suggested by Sherman as the daily requirement of a growing child, 1 gram per day.[71] No such increase in the calcium content was evident in the diets of the 59 women who were lactating at the time the diet was taken. The average in the diet of these 59 women was 0.30 gram of calcium as against an average of 0.26 gram for the 53 women who were no longer lactating.

Caloric content.

Though at the time when the dietary data were gathered it was not the plan to calculate the caloric content of the mother's diets, it was later decided upon because the diets were found to be so inadequate in other respects.

The caloric content of each daily diet was estimated as closely as possible from average helpings of reported foods. The maximum estimated number of calories per day in these 112 diets was 1,441, the minimum 220, and the average 870. That this average is so very low is at least partly accounted for by the fact that the amounts of sugar and other sweets and of bread, articles of diet that are obviously high in calories, were not recorded. Though sugar was probably used very freely in coffee, bread and such sweets as pastry and cakes were used relatively little. If the amounts of these foods used were added to the total, this addition would, of course, raise the average number of calories considerably. It is possible, moreover, that the mothers whose diets were low in the recorded foods increased the caloric content of their diets by using sugar, and possibly bread, proportionally even more than those whose diets were high in the recorded foods. If this is true, the number of calories would be increased more in the diets that were low in the recorded foods than in those higher in the recorded foods.

There is no way of estimating exactly the caloric value of the sugar and small amounts of bread that were eaten; but if the general average of 870 calories were increased 50 or 75 per cent to allow for sugar,

[68] Sherman, Henry C.: Chemistry of Food and Nutrition, p. 287.
[69] Id.
[70] Ibid., p. 512.
[71] Id.

bread, and sweets, or even if it were doubled, it would still fall below the minimum energy requirement of approximately 1,800 calories [72] for a woman of 50 kilograms in body weight who is in normal health and who spends eight hours in sleep, eight hours in sewing, ironing, sweeping, or other types of light housework, and eight hours in sitting or standing at rest.

That the Puerto Rican women were able to maintain their body weight even at a poor level on such a low energy intake may perhaps be accounted for partly by the fact that on the whole their work was light and the climate is warm. It is probably true also, as suggested by Sherman,[73] that "chronic undernutrition in adults, or even simple restriction of food consumption in health, if continued sufficiently, may bring the organism to a lower level of energy metabolism than would be indicated by the weight or surface."

It should be remembered, however, that 59 of these 112 women not only had to maintain their own weight but had to provide food for a nursing infant. Moreover, the unsatisfactory nutritional condition of the women indicated that the caloric content of their diet was probably inadequate.

It has already been pointed out that Table 22 shows for each diagnostic group the average and the range in calcium, protein, and calories. It will be seen that on the average the diets of the mothers of the children showing atrophy of the bones were but slightly lower in calories and protein than either of the other groups. They were, however, approximately one-third lower in calcium than the diets of the mothers of the children with "doubtful" roentgenograms, and one-quarter lower than those of the mothers of children with normal roentgenograms. The numbers in each group are too small to allow any conclusions to be drawn. It should be pointed out, moreover, in this connection that most of the children in the group showing osteoporosis (18 out of 28) had been weaned and that the calcium in the mother's diet can not, therefore, be regarded as indicative of the calcium in the children's diet. It may, however, indicate the amount of calcium in her diet before weaning took place and thus have some bearing on the child's condition.

No explanation of the greater amount of calcium in the diets of mothers whose children had doubtful roentgenograms is suggested. On the whole this group of children were younger (mostly under 6 months of age), and most of them were breast fed (21 out of 28). In the New Haven study doubtful diagnoses were made more often in young infants, and it had been suggested at the time of this study that it was perhaps less easy to be certain of the condition of the bones when growth was taking place rapidly. It is possible that this factor of rapid growth entered into the doubtful diagnoses in the Puerto Rican children. The higher calcium content of the diets of the mothers in this group might, under such circumstances, be associated with more rapid growth of the child. There is not enough evidence, however, to substantiate such a hypothesis.

The diets of this sample of 112 mothers were deficient in calcium, protein, and calories, but the deficiency in calcium is in all probability the most serious, the calcium content falling approximately 40 per

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[72] Calculated from figures in Chemistry of Food and Nutrition, by Henry C. Sherman, (New York, 1932), pp. 195–196.
[73] Ibid., p. 184.

cent below the optimum for mothers no longer lactating and even more below the optimum for mothers who are lactating. The deficiency of calcium in the mothers' diets probably indicates a similar deficiency in the diets of the other members of the family, with the exception, perhaps, of children who were breast fed or who were receiving more than a cup of cow's milk a day. Though it can not be demonstrated, it is suggested that the osteoporosis of the bones found in so many of the children may be a reflection of this deficiency of calcium in the diet. (See pp. 56–59.)

CLASSIFICATION OF DIETS OF ALL MOTHERS INTERVIEWED

Using the 112 sample diets to show the variation in foods eaten and in the calcium and protein content of these foods, five grades were established, into which the diets of all the mothers would fall. These grades were based primarily on the calcium and protein content of the diets. The average and range of the calcium and protein content of the diets in each of these grades and the combinations of foods that fell within each range are as follows:

Diet grade	Calcium (grams)			Protein (grams)			Combinations of food falling within range of calcium and protein
	Average	Maximum	Minimum	Average	Maximum	Minimum	
1. Good	0.66	0.87	0.46	50	65	36	Milk, 1 cup or more a day. Eggs, 3 or more times a week. Leafy vegetables, 3 or more times a week. Beans or tuberous vegetables,[74] 2 or more times a day. Rice, potato, or bread 2 or more times a day. Meat, 5 or more times a week. Oranges, 3 or more times a week.
2. Fair	0.37	0.55	0.18	41	53	28	Milk, few teaspoonfuls (in coffee) to 1 cup. Eggs, 1 or 2 times a week. Leafy vegetables, 1 or 2 times a week. Beans or tuberous vegetables, 7 or more times a week. Rice, potatoes, or bread, 2 or more times a day. Meat, 3 to 7 times a week. Oranges, 1 to 4 times a week.
3. Poor	0.20	0.28	0.12	37	50	24	Milk, none.[75] Eggs, or leafy vegetables, 1 or more times a week. Beans or tuberous vegetables 7 or more times a week. Rice, potatoes, or bread, 2 or more times a day. Meat, 3 to 7 times a week. Oranges, 1 to 4 times a week.
4. Very poor	0.15	0.24	0.06	18	28	7	Milk, few teaspoonfuls (in coffee). Eggs, or leafy vegetables, none or 1 to 2 times a week. Beans or tuberous vegetables, 3 or more times a week. Rice, potatoes, or bread, 1 or 2 times a day. Meat, once a week. Oranges 1 to 4 times a week.
5. Exceedingly poor.	0.08	0.14	0.02	15	26	4	Milk, none. Eggs or leafy vegetables, none, or once a week. Beans or tuberous vegetables 3 or more times a week. Rice, potatoes, or bread 1 or 2 times a day. Meat, none, or once a week. Oranges, none, or 1 to 2 times a week.

[74] Tuberous vegetables include, as well as potatoes, such native vegetables as yams and yautias. At the time when the calcium content of these diets was calculated, no figures as to the amount of calcium in the yautia could be found. It was assumed that in calcium content the yautia was somewhere between the potato and the turnip, both of which the yautia resembles. Through a subsequent analysis the yautia has been found to be actually much lower in calcium than the estimate used in the present study. (Significance of Mineral Metabolism, I. Preliminary Report on Calcium and Phosphorus Content of Some Puerto Rican Food Materials, by D. H. Cook and Trinita Rivera, in the Puerto Rican Review of Public Health and Tropical Medicine, vol. 4, no. 2, pp. 65–69, August, 1928.) The amounts of calcium in these diets, therefore, are as a whole somewhat overestimated.

[75] Though the diets in the third grade contain no milk, they are slightly better than those in either the fourth or the fifth, because they include larger amounts of calcium and protein containing foods other than milk.

On the basis of calcium and protein content the diets that would fit into the first grade could, on the average, be called "good" and those near the top of the range within this grade "very good." Whether those near the bottom of the range should be called "good" on the basis of but one cup of milk a day is very doubtful. The second grade, called "fair," provides for the diets that on the average contained at least the daily maintenance requirement of calcium and protein for a woman of 50 kilograms; the diets in the third, fourth, and fifth grades are all three poor, and fall progressively lower. The diets in the fourth and fifth grade are both very poor, but may be distinguished from each other, as the fourth contains a very small amount of milk and the fifth contains none.

Diets reported for day before interview.

Table 23 shows the grades given to the diets eaten by 484 mothers on the day before the interview and also the calcium content of each diet group (calcium content not calculated for 2 mothers' diets). The poverty of the diets is very striking. That only 10 per cent of the total group of mothers had eaten foods that could be graded as "good" is no less worthy of note than that nearly 9 per cent were so exceedingly poor as to fall in a group below the usual "very poor" one.

The average amounts of calcium and the range calculated for the different diet groups indicate the quality of each grade from the point of view of calcium content. As was done in studying the sample of 112 mothers' diets, the average amount of calcium in the day's food was calculated for the total group of 482 mothers. This was found to be 0.29 gram, an amount almost identical with the average for the sample and therefore also slightly lower than the amount calculated as a daily maintenance allowance for a woman of 50 kilograms, 0.32 gram. (See pp. 82–83.)

TABLE 23.—*Calcium content of mother's diet on day previous to interview, and diet grade; families visited in Puerto Rico*

Diet grade	Families visited		Calcium content (gms) of mother's diet [1]		
	Total	Per cent distribution	Average	Maximum	Minimum
Total	506				
Grade reported	484	100	0. 287	1. 345	0. 048
Good	48	10	. 614	1. 345	. 456
Fair	194	40	. 338	. 638	. 183
Poor	93	19	. 211	. 328	. 127
Very poor	[2] 107	22	. 180	. 238	. 067
Exceedingly poor	[2] 42	9	. 104	. 145	. 048
Grade not reported	22				

[1] For foods recorded see p. 85.
[2] Includes 1 diet for which calcium content was not reported.

Diets reported for periods of pregnancy and lactation.

With a view to determining whether any improvement was made by Puerto Rican women in their diet during periods of lactation, the foods recorded as eaten on the day before the interview by the mothers

who were still lactating were compared with the foods recorded for those no longer lactating, and almost no difference was found. Apparently, as a general thing, mothers in Puerto Rico do not or can not get a better diet during lactation than that which they take usually. Moreover, no significant difference was found between the lactating and the nonlactating women with regard to the inclusion of milk in their diets, and the average calcium content of the diets was found to be about the same in the two groups, the diets of the mothers who were still lactating averaging 0.29 gram and those of mothers no longer lactating averaging 0.28 gram. As was true of the sample diets already discussed, the calcium content of the diets of the mothers who were carrying the extra burden of lactation was, therefore, not only far below the "standard" allowance (see p. 83), but even farther below the allowance desirable for lactating women.

Table 24 shows a comparison of the grades given to diets eaten by mothers during 531 periods of pregnancy and during 505 periods of lactation (combining complete and incomplete periods) with the grades given to diets eaten on the day previous to interview by 197 mothers who were no longer lactating. The latter group probably represents the usual grade of diet eaten by Puerto Rican women.

Contrary to what might be expected, however, it can be seen that the diets taken by the mothers during pregnancy were slightly, but definitely, better than those taken on the day previous to the interview and also better than the diets taken during the lactation periods. The greatest difference was found in the proportion of mothers who during pregnancy took enough milk to have their diets classified as good. Though the differences found are slight, they are large enough, in all probability, to be considered significant and to indicate a tendency on the part of some Puerto Rican women to improve their diets during pregnancy, though the same effort apparently was not made during lactation.

TABLE 24.—*Diet grade of mothers during pregnancy, during lactation, and on day previous to interview for mothers not lactating on that day*

Diet grade	Periods of pregnancy		Periods of lactation		Mothers not lactating on day previous to interview	
	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution
Total	[1] 556		[2] 526		[3] 213	
Grade reported	531	100	505	100	197	100
Good	98	19	60	12	15	8
Fair	205	39	208	41	76	39
Poor	82	15	89	18	44	22
Very poor	109	21	109	22	45	23
Exceedingly poor	37	7	39	8	17	9
Grade not reported	25		21		16	

[1] Of the 506 mothers in families visited, 50 had two children examined, and information was sought with regard to these mothers' diets during both pregnancies.
[2] Of the 506 mothers in families visited, 50 had two children examined; of the 556 children examined, 30 were never breast fed.
[3] Of the 506 mothers in families visited, 293 were lactating on the day previous to interview.

Grade of mother's diet in relation to income.

That the quality of the mother's diet is closely related to income is shown in Table 25, and has already been referred to in the section on Income (p. 68). Since individual diets are under consideration, the income per capita has been used rather than the total family income. As would be expected, income influenced the quality of the mother's diet to a great extent. Of the mothers reported as receiving good or fair diets, nearly two-thirds were in families with per capita incomes of $100 or more; of those who had poor diets, only one-third had incomes as high. The high cost of milk in Puerto Rico and its scarcity are probably responsible for this, since the amount of milk was given great weight in grading the diets, but the high cost of eggs, butter, meat, and fresh green vegetables is also without doubt a contributory factor.

TABLE 25.—*Mother's diet grade for day previous to interview and annual per capita income of family; families visited in Puerto Rico*

Diet grade	Families visited						
	Total	Annual per capita income					
		Less than $50	$50, less than $100	$100, less than $150	$150, less than $200	$200 or more	Not reported
Total	506	66	130	91	38	52	129
Good	48	1	7	6	7	19	8
Fair	194	14	50	51	18	20	41
Poor	93	19	27	14	4	4	25
Very poor	107	18	32	16	8	6	27
Exceedingly poor	42	11	10	3	1	2	15
Not reported	22	3	4	1		1	13

DIETS OF CHILDREN

METHOD OF COLLECTING INFORMATION ON DIETS

When the information on Puerto Rican children's diets was being collected, an effort was made to collect it in such form that a general description of the diets from the child's birth to the time of the examination could be given and that the quality of the diet at the time of examination could be studied in relation to the physical condition of the child. The diet information for the child was obtained from the mother at the time the home was visited, which was, as a rule, a few days after the physical examination of the child. The food eaten by the child on the day before the home visit was recorded and also a statement from the mother giving in as great detail as possible an account of the child's diet from the time of his birth to the date of the visit. As the majority of the children were 1 year of age or under at the time of the visit, and the rest in the second or third year, it was possible for the mothers to remember with a fair degree of accuracy the time at which certain events took place, such as weaning and the addition to the diet of cow's milk and of various solid foods. The age when certain foods were first used was recorded in months. It was realized, however, that there could easily be an error of one or two months either way; the time of such changes in diet has, therefore, been considered as only approximate.

The exact quantities of food eaten by the child daily were not recorded, with the exception of milk, but the frequency with which such articles of diet as fruit, eggs, leafy vegetables or other vegetables, and cereals (including rice) were used and the time when they were first used were recorded. The daily quantity of cow's milk, whether in a formula or otherwise, and whether supplementary to breast feeding or not, was recorded, as well as variations in amount from period to period.

METHOD OF GRADING DIETS

As with the mothers' diets, each child's diet was graded so that it might be compared with that of the other children and might be studied in relation to such factors as income and physical condition. As changes in diet occur at shorter intervals during the first year than in later ones, the first year of the child's life was divided for the purpose of description of his diet into four periods of three months each, whereas the second and the third years were not divided; instead, a whole year, or that part through which the child had lived, was used as the unit for grading. A diet grade was given for each period, even if it was incomplete. Thus a child 2 months old would receive one grade—a grade for the first 3-month period, even though incomplete. A child 5 months old would receive two grades—a grade for his first 3 months of life and a grade for the second 3 months, even though the second period was incomplete. A child just a year old would receive four grades— one for each of the 3-month periods of the first year.

The second year, whether complete or incomplete, was treated as a single period and given one grade; the third year was treated in the same way. Thus a child 16 months old would receive 5 grades— a grade for each of the 4 complete 3-month periods of the first year and a grade for the second year, even though incomplete. A child 2½ years old would receive 6 grades—4 for the first year, 1 for the second, and 1 for the third.

By this method of grading the children's diets at various age levels, it was possible to study the adequacy of diets at different ages, to compare different groups of children on an age basis, and, in addition, to study the relation of the diet at the time just before the examination (the most recent diet period, even if incomplete) to the physical condition of the child at the time of examination. It may be said here that essentially no difference was found in the quality of the children's diets taken during a given period with respect to whether the period was complete or incomplete.

BASIS FOR GRADES OF DIETS AT DIFFERENT AGES

The grades for diets in the different age periods were based in general upon standards for feeding infants and young children generally used in continental United States, with some adaptation to fit the customs in Puerto Rico. Five grades were given: "Very good," "good," "fair," "poor," and "very poor." For each age period the "very good" grade represents a relatively good type of feeding but not always one equal to what would be described as "very good" in continental United States. This is especially true of the second and third periods, in which the standards for foods in addition to milk [76]

[76] Infant Care, p. 78, U. S. Children's Bureau Publication No. 8. Washington, 1933.

have been kept low in an attempt to adjust the grading to local customs. The "good," "fair," and "poor" grades also are based on standards lower than those accepted in continental United States. For example, the diets in the very good grade for periods two and three (especially in period three), are not up to the usual standards, which require that vegetables and eggs, as well as cereal, be begun during these months. The poor and very poor grades include many diets that are exceedingly low in both quality and quantity. For grades given to diets at different age periods see Appendix Tables D1 to D6 (pp. 114–119).

The diet grades were based first on the type of milk feeding—breast feeding or artificial feeding—and, if the child was artificially fed, the quantity of cow's milk and secondly, upon solid foods—the kinds of solid foods, the number of times a week they were used, and the age at which they were begun. In general, as the child grew older, breast milk was given decreasing weight in the grading, and cow's milk and solid foods, increasing weight. Since nearly every child was found to receive some orange juice or other form of fresh fruit almost daily, fruit was not taken into consideration in grading.

In the grading of milk feeding, breast milk was considered the most satisfactory type for a child during the first 9 months of life. This was decided upon with full recognition of the fact that in many instances the mother's diet was so inadequate as probably to affect the quality and quantity of her milk. For the first 3-month period of the first year breast milk, unsupplemented by cow's milk, was considered the most satisfactory type of milk feeding; for the second 3-month period (4 to 6 months) and the third 3-month period (7 to 9 months) breast feeding, either alone or in major part,[77] was considered most satisfactory. For the third 3-month period (7 to 9 months), if breast feeding was found to be the minor part of the baby's milk feeding and 1 pint or more of cow's milk a day was given to supplement it, or if an average of $1\frac{1}{2}$ pints of cow's milk alone was given, the milk feeding was considered satisfactory.

After the first 9 months of life, breast feeding, unsupplemented, was no longer considered the most satisfactory type of milk feeding, but instead, an adequate amount of cow's milk ($1\frac{1}{2}$ pints to 2 pints) or a small amount of breast milk with 1 pint or more a day of cow's milk in addition was so considered. During the second and third years the grading of milk feeding was based on cow's milk alone, $1\frac{1}{2}$ pints or more a day being considered a very satisfactory amount of milk, 1 pint satisfactory.

For children under 3 months of age no solid food was required to have the diet considered very good, a very satisfactory milk feeding alone being enough.

In the grading of the diets for the age periods after the first three months, however, increasing weight was given to the addition of solid foods to the child's diet, namely, cereal (usually rice), vegetables (usually some form of dried beans, but occasionally fresh vegetables such as string beans or lettuce), and eggs. The use of rice water in

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[77] When a child was partly breast fed and partly artificially fed, it was not possible to tell exactly what proportion of his milk feeding was from the breast. If a child was breast fed for more than half of a 3-month period or if he received an average of only 1 cup of cow's milk a day (less than 12 ounces, in addition, the breast milk was empirically considered to be the major part of his total milk feeding in that period. If he was breast fed less than half of a 3-month period or received an average of 1 pint of cow's milk a day (12 to 20 ounces) or more, the breast milk was considered to be the minor part of his milk feeding in that period.

feeding formulas during the first 9 months of life was counted as the use of cereal, though the investigators realized that relatively little value was added to the diet in this way.

For children 4 to 9 months of age only one solid food had to be given daily in addition to a satisfactory milk feeding to have the diet considered very good or good. That this standard for solid food during the period from 4 to 9 months was low in the light of modern standards for infant feeding was recognized; but it proved to be relatively high for the usual Puerto Rican infant's diet.

In the age period 10 to 12 months the very good diet grade included what was considered an adequate amount of all three solid foods; that is, eggs and vegetables used 2 to 6 times a week each, as well as cereal once or twice daily. If such foods were eaten in combination with 1½ pints of cow's milk a day or with a pint of cow's milk a day supplementing breast feeding, the whole diet was considered very good; if 1 pint of cow's milk a day was given, or only an average of 1 cup supplementing breast feeding, or, if the child's milk feeding was entirely from the breast, and cereal, eggs, and vegetables were all taken in adequate amounts, the diet as a whole was considered good. The fair, poor, and very poor grades represented less and less adequate use of solid foods combined with less and less adequate milk feedings.

The grades for the use of solid foods during the period from 10 to 12 months were given as follows:

Grade	Cereal	Eggs and vegetables
Satisfactory	Once or twice a day	Each food 2 to 6 times a week.
Borderline	Once or twice a day	Either food 2 to 6 times a week *or* One food once a week, the other 1 to 6 times a week.
Poor	Once or twice a day	Either food once a week or neither given.

During the second year also the grade of the child's diet depended both on the kind and quantity of milk and on the use of cereal, eggs, and vegetables. No diet was considered either very good or good unless both cow's milk and these specified solid foods were well represented. To be graded as very good, a diet had to contain 1 pint or more of cow's milk a day, and all three solid foods had to be used to an extent considered very satisfactory. To be graded as good, a diet had to contain 1 pint or more of cow's milk and all three types of solid foods in amounts considered satisfactory. Whether the use of solid foods was satisfactory depended not only on the number of times a week that each was given but on how early in life the use of these foods was begun. Throughout the grading of the second-year diets, the time when eggs and vegetables were started was given considerable weight in determining the grade of the diet. When, as frequently happened, eggs or vegetables were given in fair or poor amounts or were not started until the child was 13 months or older the grade of the diet as a whole was low.

The grades for the use of solid foods during the second year were given as follows:

Grade	Cereal	Eggs and vegetables	
	How often eaten	How often eaten	At what age begun
Very satisfactory	1 to 2 times a day____	Each food 5 to 7 times a week_____	Both foods at or before 12 months, *or* One food at 12 months, the other at 13 to 15 months.
	1 to 2 times a day____	Each food 3 to 7 times a week_____	Both foods at or before 12 months.
Satisfactory	1 to 2 times a day___	Each food 5 to 7 times a week_____	Both foods at 13 to 15 months.
	1 to 2 times a day____	Each food 3 to 7 times a week_____	One food at 12 months, the other 13 to 15 months.
	1 to 2 times a day____	One food 3 to 7 times a week, the other 0 to 2 times.	Both foods at or before 12 months.
Borderline	1 to 2 times a day____	Each food 3 to 7 times a week_____	One food at or after 16 months, the other before 16 months, *or* Both foods at 16 months.
	1 to 2 times a day____	Each food 3 to 7 times a week, *or* One food 3 to 7 times, the other 0 to 2 times.	Both foods at 13 to 15 months.
	1 to 2 times a day____	One food 3 to 7 times a week, the other 0 to 2 times.	One food at 12 months, the other at 13 to 15 months.
Unsatisfactory	0 to 2 times a day____	Each food 3 to 7 times a week ___	One food at or after 16 months, the other before 16 months.
	0 to 2 times a day____	One food 3 to 7 times a week, the other 0 to 2 times.	One food at or after 16 months, the other before 16 months, *or* Both foods at 16 months.
	0 to 2 times a day____	Neither food in diet *or* Either food 1 to 2 times a week.	Both foods at or before 12 months, *or* One food at 12 months, the other at 13 to 15 months, *or* Both foods at 13 to 15 months.
Very unsatisfactory	0 to 2 times a day____	One food 3 to 7 times a week, the other 0 to 2 times.	One food at or after 16 months, the other before 16 months.
	0 to 2 times a day____	Neither food in diet *or* Either food 1 to 2 times a week.	One food at or after 16 months, the other before 16 months, *or* Both foods at 16 months, *or* One food at or after 16 months, the other before 16 months.
	0 to 2 times a day____	[78]_____	[78].

[78] Neither eggs nor vegetables in diet.

The diet grades for the third year also were based on the use of milk and solid foods, the same standards in general being used as for the second year.

GRADES GIVEN TO DIETS

Chart IX [79] shows, for successive periods of the first two years of the child's life, the percentage distribution of the grades given to the diets taken by the children for whom diets were reported. It will be seen that in these two years, according to the grading plan used, the diets deteriorated rapidly in adequacy. In the early periods, as has

[79] For data upon which Chart IX is based, see Appendix Tables D1, D2, D3, D4, and D5.

already been pointed out, the most important element that affected the grades given to the diets was breast milk; in later periods it was cow's milk and solid foods—especially solid foods.
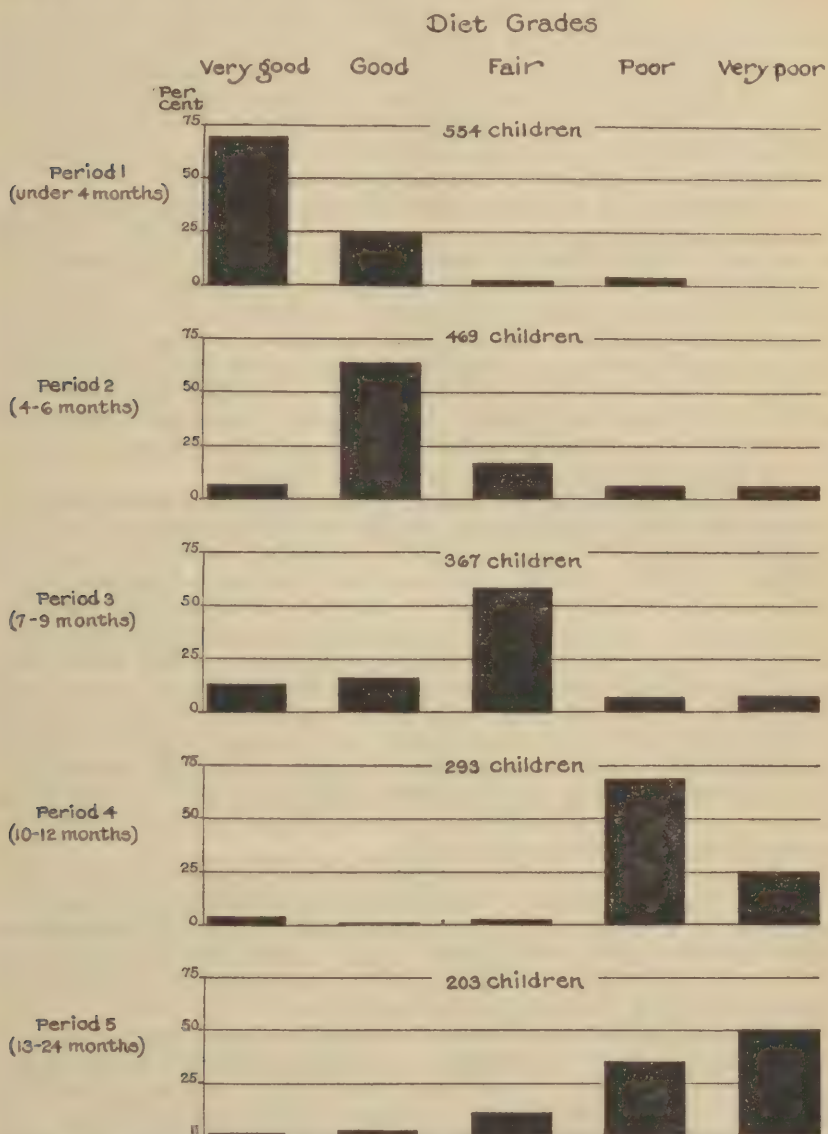
Diet Grades

CHART IX.—Diet grades during specified age periods in the first 2 years of life; Puerto Rican children 1 to 34 months of age

Breast feeding, either alone or supplemented with feedings of cow's milk, was continued for more than half the children to the end of the first year. During the second year, or that part of it through which the child had lived up to the time of interview, breast feeding was continued for about two-fifths of the children. In the period between

10 and 12 months, only about half the children received what was considered a relatively satisfactory amount of cow's milk (1 pint or more), either alone or as supplementary to breast feeding. Nearly all the rest of the children were still breast fed, either entirely or with supplementary feedings of less than 1 pint of cow's milk a day; a very few received no breast milk and an inadequate amount of cow's milk. During the second year (or that part of it through which the child had lived) half the children received 1 pint or more of milk daily, the majority of the rest receiving only an average of 1 cup of cow's milk daily, either alone or supplementary to breast milk. A very few children were still entirely breast fed in the second year.

For infants during their first three months of life solid food did not enter into the grading, the diet grade being based on the type of milk feeding only. In the diets of children 4 to 6 months of age the use of any sort of solid food in addition to milk was relatively uncommon. Of the 469 children graded for this second 3-month period only a small proportion (19 per cent) had received cereal in any form. Two children only were reported as having had vegetables in this second period and 1 as having had eggs. Since, however, the diet grades in this period were planned so as not to depend greatly upon the addition of solid food, but more upon breast feeding, a large proportion of the diets of children of this age were graded as "good."

In the third period, from 7 to 9 months of age, only 144 of the 367 children whose diets were graded (39 per cent) received any solid food in addition to milk. Many of these received cereal only; only 32 received vegetables, with or without cereal; and only 3 received eggs. In the fourth period, from 10 to 12 months, 172 of the 293 children whose diets were graded (59 per cent) received some solid food in addition to milk. Of these, 98 received cereal only (usually rice); 69, vegetables, (usually dried beans, but occasionally a green vegetable) either alone or in combination with other foods; and 9, eggs, either as the only solid food or in combination with others. In spite of the fact, then, that by the end of the first year of life about half the children were receiving 1 pint or more of cow's milk daily, very few could be graded as having very good, good, or even fair, diets because of the extreme lack of supplementary foods.

In the second year only 2 of the 203 children received all three solid foods in "very satisfactory" amounts; 9 received all three foods in satisfactory amounts; 27 received vegetables or eggs or both in borderline amounts, as well as enough cereal; and 165 in unsatisfactory amounts, or none at all. Ten received no solid food at all, not even cereal; these diets were in the very poor grade.

The diets taken by these Puerto Rican children were, then, far below the standards usually accepted in continental United States with regard to the quantity of milk and also with regard to the use of other foods usually considered necessary. It is not surprising that during the period when a full diet of cow's milk and solid foods should have been established the nutritional condition of the children became increasingly unsatisfactory.

VALUE OF BREAST FEEDING IN RELATION TO MOTHER'S DIET

The classification of the children's diets has been based upon the empirical assumption that breast feeding, regardless of the adequacy of the mother's diet, is, when supplemented at appropriate ages by

certain additional foods, the best method of feeding children under 10 months of age, and that after 10 months an adequate amount of cow's milk, with liberal use of certain solid foods, constitutes the best diet. As the mothers' diets during both pregnancy and lactation were on the whole poor (see p. 86), it may well be questioned whether breast feeding should have been considered very satisfactory for these children. Recent experimental work has shown that the quality of the mother's diet influences the nutritive value of her milk.[80] As 95 per cent of the children were breast fed either entirely or partly during the first 3 months of life, and 77 per cent during the period from 4 to 6 months, there would seem to be ample opportunity to show the effect of inadequacy of the mothers' diets on the ability of the mothers to nurse their children.

Comparison, however, of the diets eaten during lactation by women who were able to nurse their children through six months with those who did not nurse them after the first three months shows little difference in the quality of the diets. Indeed, a larger proportion of mothers who nursed their children through six months than of those who nursed their children for less time than that reported diets that fell in the two poorest groups. The quality of the mother's diets during lactation apparently did not influence the length of the nursing period.

So, too, the diets eaten during pregnancy could not be shown to have influenced the length of the nursing period. The fact that there were so few women whose diets could be classified as really good may account for the lack of contrast between diets of good quality and of poor quality in their effect on the length of the nursing period.

Considering the poverty of these mother's diets, the question may very well be raised with regard to the desirability of grading breast feeding as very good, but since the real quality of the breast milk was not known, and since many of the artificial formulas substituted would probably have been even more inadequate, as can be judged from the few reported during these first 6 months (see Appendix Tables D1 and D2), it seemed best to consider breast milk as the most satisfactory food on the whole for these children in their early months.

CHILD'S PHYSICAL CONDITION IN RELATION TO DIET AT TIME OF INTERVIEW

The assumption that breast milk was on the whole the best food may be shown to be reasonably correct by comparing the nutritional condition of children who were examined during periods when breast milk was the chief part of the diet with that of children who were examined in later age periods, when breast feeding was less common, and also by studying the relation of the diets as a whole that the children were receiving at the time of examination to their physical condition.

It has already been pointed out in the section on physical condition of the children (see p. 26) that the children who were examined during the first 6 months of life showed on the whole more satisfactory amounts of subcutaneous fat than those examined during later months, and also (see p. 22) that the children under 6 months more nearly approached the average weight for age of white children in continental

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[*] McCollum, Elmer V., and Nina Simmonds: The Newer Knowledge of Nutrition, pp. 410–432. New York, 1929.

United States than did those over 6 months. This alone would point to the fact that the breast milk that these children were receiving, regardless of its quality, was in all probability a more satisfactory food
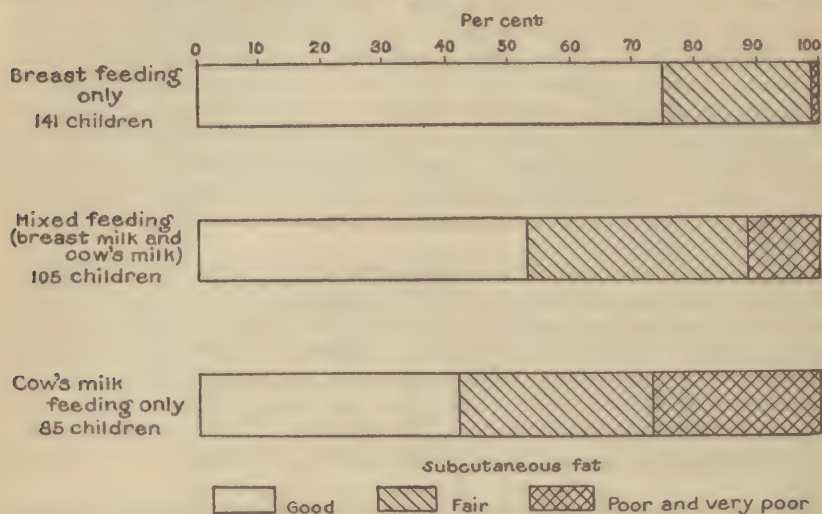
CHART X.—Subcutaneous fat in relation to type of milk feeding at time of examination; Puerto Rican children 13 months of age and under

for children of this age than any food that the older children were receiving. Moreover, when children 1 year of age or under were studied, a definite relation was found between the food that the child
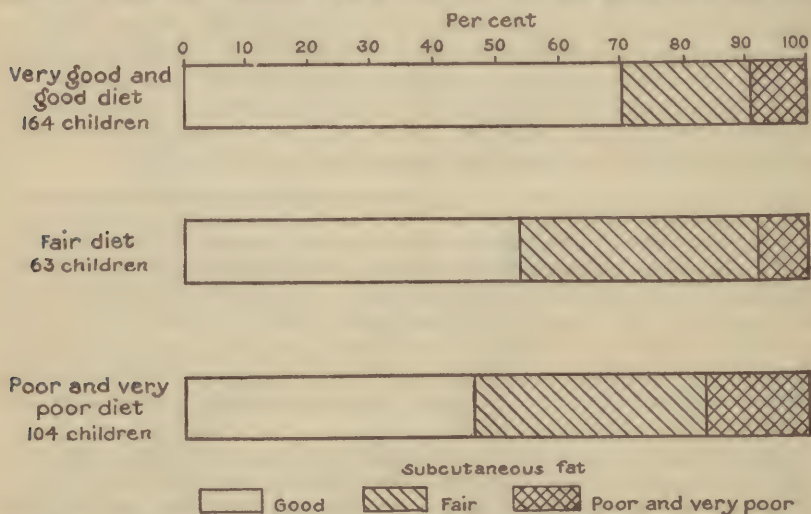
CHART XI.—Subcutaneous fat in relation to diet grades at time of examination; Puerto Rican children 13 months of age and under.

was receiving at the time of examination and the child's physical condition as shown by the amount of subcutaneous fat. This relation may be seen in Charts X and XI. From Chart X there would seem to be little doubt that during the first year of life children who were

entirely breast fed up to the time of examination, that is, received no cow's milk at all, were the most satisfactorily nourished, whereas those on cow's milk alone were the least satisfactorily nourished. In this connection, however, it should be pointed out that 70 per cent of the 141 children who were entirely breast fed at the time of examination were at that time under 7 months of age and that only 22 per cent of those receiving no breast milk were equally young.

When the grade for the entire diet (solid food as well as milk) that the child was receiving at the time of the home visit was considered in relation to the amount of subcutaneous fat, a similar though somewhat less striking relation was found; this is shown in Chart XI.

From the study of the nutritional condition of the children and of their diet it would appear that breast feeding, regardless of the quality of the mother's diet, was the diet that brought relatively the best results; but it is also apparent that after the children became 6 months of age even these results were not satisfactory according to general standards in use in continental United States. If the mother's diet had been better, and if adequate solid foods had been included in the child's diet in addition to the breast milk, the nutritional condition of the children would, without much doubt, have been better.

ECONOMIC CONDITION OF FAMILY IN RELATION TO CHILD'S DIET

The grade of the child's diet as a whole and the type of milk feeding were studied separately in relation to several economic conditions— the per capita income of the family, the number of persons who were sharing the family diet, and, if the father had been unemployed, the duration of his unemployment—but no relation was found. The absence of any such relation is probably due to the fact that the great majority of incomes were so low that contrasts could not be drawn.

SUMMARY

The main part of this investigation consisted in obtaining roentgenograms of the forearm bones of nearly 600 children under 3 years of age living in Puerto Rico, where children are exposed to sunlight all the year round. These were obtained so that they might be compared with roentgenograms of children of the same age group living in New Haven, where much less sunlight is available. Besides the roentgenographic examinations, physical examinations were given to the children.

As part of the physical examinations, the weight and height of each child were taken. In weight the group of Puerto Rican children examined fell considerably below a group of children examined some years before in continental United States, and in height the Puerto Rican group fell somewhat below it. The differences for children under 6 months of age were, however, less than those for children over 6 months.

Many of the children examined seemed to be poorly nourished. From study of the final tabulations it is apparent that the point of view of the physicians became warped as they proceeded with the examinations and that their standards for the various grades of nutritional condition were unintentionally lowered by the prevalence of poorly nourished children. Grades for subcutaneous fat are given in the report in order to show the variation within the Puerto Rican group, but these estimates should not be compared grade for grade with estimates for children in continental United States, since the grade "good" given to the group in Puerto Rico is probably comparable with the grade "fair" as used in continental United States, and so on.

Special clinical and roentgenographic examinations were made in order to determine whether rickets was as infrequent in this region as would be expected on account of the sunny climate. At clinical examination 50 children (about 9 per cent of those examined) were thought to show (usually in slight degree) the physical signs that are commonly considered evidence of rickets. At roentgenographic examination, only 5 (less than 1 per cent) showed evidence of rickets—3 in a slight or very slight degree and 1 in an advanced degree; 1 showed a healed process of many months' standing. Study of the roentgenographic incidence of rickets and of the relation of the roentgenographic incidence to the clinical has led to the belief that many of the clinical diagnoses of rickets made during the present study were wrong and that the physical signs upon which they were based were in all probability within the limits of variation of normal growth and development.

The slight deviations from the preconceived normal which had been considered signs of slight rickets in a previous study made in New Haven by the United States Children's Bureau in cooperation with the department of pediatrics, Yale University School of Medicine, were almost totally absent (3 children with such deviations out of 584 children examined). It is therefore concluded that the deviations

found in the New Haven study were properly considered signs of rickets and that the standards of normal used in that study were not too limited.

A report is given of 59 cases of marked osteoporosis occurring in children who, with the exception of 2, had no rickets, and it is suggested that the osteoporosis was due to gross inadequacies in the diet, especially inadequacy of calcium.

The incidence of transverse lines appearing in the roentgenograms of the bones of the forearm was studied. These lines are thought to be evidence of intermittent growth and, as was expected, were found more frequently in these Puerto Rican children than in children of the same age in New Haven.

The socio-economic conditions under which the families were living at the time of the investigation were studied—the size of the families, housing facilities, income, and diet. The diets of the mothers and children were considered of especial interest because of the relation of the content of these diets to the growth of the children and to the roentgenographic appearance of their bones. The low calcium content of the mothers' diets was most striking and was due primarily to the fact that almost negligible amounts of milk were taken by a majority of the women. The calcium content of the children's diets could not be calculated, but it is probable that the inadequacy of calcium in the mothers' diets is characteristic of the diets of the children also. The quality of the children's diets deteriorated rapidly after the breast-feeding period was over. Unsatisfactory amounts of cow's milk were given to at least half the older children. The solid food that was given was added to the diet later than is usual in continental United States and was insufficient in amount and variety; the use of green vegetables and of eggs was relatively rare. The basis of the average child's diet after weaning was rice, beans, and coffee, with a little milk and, occasionally, green vegetables. The diets of both mothers and children were grossly inadequate, especially as regards milk and green vegetables.

Appendix A.—HEIGHT, WEIGHT, AND HEAD CIRCUMFERENCE FOR AGE: CHILDREN EXAMINED IN PUERTO RICO

TABLE A1.—*Height and age; boys 1 to 33 months of age examined in Puerto Rico*

Boys 1 to 33 months of age

Age [1] at examination	Total	Total reported	Height (centimeters) reported																							Height not reported
			47, less than 49	49, less than 51	51, less than 53	53, less than 55	55, less than 57	57, less than 59	59, less than 61	61, less than 63	63, less than 65	65, less than 67	67, less than 69	69, less than 71	71, less than 73	73, less than 75	75, less than 77	77, less than 79	79, less than 81	81, less than 83	83, less than 85	85, less than 87	87, less than 89	89, less than 91	91, less than 93	93, less than 95	
Total	307	304	1		2	11	10	7	15	26	24	20	28	28	27	21	23	15	14	11	7	4	5	3		2	3
Age reported	295	292	1		2	11	10	7	14	25	23	20	26	28	26	18	23	14	14	11	7	4	3	3		2	3
1 month	9	8	1		1																						1
2 months	11	11			1	5																					
3 months	16	16				2	1																				
4 months	19	19				4	5																				
5 months	18	18					3	1	2	4																	
6 months	16	16					1	1	2	8																	
7 months	13	13						2	1	5																	
8 months	17	17						2	3	3																	
9 months	13	13						1	2	3																	
10 months	15	15							1	1																	
11 months	17	17							1	1																	
12 months	12	12							1																		
13 months	9	9							1																		
14 months	8	8																									
15 months	8	8																									
16 months	11	11																									
17 months	12	12																									
18 months	6	6																									
19 months	10	10																									
20 months	7	7																									
21 months	4	4																									
22 months	5	5																									
23 months	7	7																									
24 months	4	3																									
25 to 27 months	14	14																									
28 to 30 months	7	7																									
31 to 33 months	7	7																									
Age not reported	12	12							1	1	1		2		1	3		1				2				

[1] Age is given as of nearest month; that is, "1 month" is from 16 days to 1 month and 15 days, inclusive, and so on.

TABLE A2.—*Height and age; girls 1 to 33 months of age examined in Puerto Rico*

Girls 1 to 33 months of age

Age[1] at examination	Total	Total reported	Height (centimeters) reported																							Height not reported
			45, less than 47	47, less than 49	49, less than 51	51, less than 53	53, less than 55	55, less than 57	57, less than 59	59, less than 61	61, less than 63	63, less than 65	65, less than 67	67, less than 69	69, less than 71	71, less than 73	73, less than 75	75, less than 77	77, less than 79	79, less than 81	81, less than 83	83, less than 85	85, less than 87	87, less than 89	89, less than 91	91, less than 93	
Total	274	272	1	1	2	1	13	9	13	17	20	14	26	13	18	19	25	23	17	10	14	3	9	2	1	1	2
Age reported	266	265	1	1	2	1	13	9	13	17	20	14	26	13	17	17	25	22	16	8	14	3	9	2	1	1	1
1 month	8	8																									
2 months	17	16	1																								
3 months	11	11																									
4 months	12	12																									
5 months	18	18																									
6 months	15	15																									
7 months	12	12																									
8 months	13	13																									
9 months	7	7																									
10 months	11	11																									
11 months	10	10																									
12 months	9	9																									
13 months	13	13																									
14 months	7	7																									
15 months	13	13																									
16 months	5	5																									
17 months	5	5																									
18 months	7	7																									
19 months	5	5																									
20 months	4	4																									
21 months	9	9																									
22 months	5	5																									
23 months	9	9																									
24 months	7	7																									
25 to 27 months	24	24																									
28 to 30 months	6	6																									
31 to 33 months	5	5																									
Age not reported	8	7																									1

[1] Age is given as of nearest month; that is, "1 month" is from 16 days to 1 month and 15 days, inclusive, and so on.

TABLE A3.—*Average height at each month of age; boys and girls 1 to 33 months of age examined in Puerto Rico*

Age [1] at examination	Average height (centimeters)			
	Boys		Girls	
	Observed	Smoothed	Observed	Smoothed
1 month	53.3	52.98	52.8	51.94
2 months	56.2	56.83	55.4	55.91
3 months	58.6	59.31	58.9	58.44
4 months	62.8	61.23	61.2	60.38
5 months	62.9	62.84	60.7	62.00
6 months	64.0	64.26	61.5	63.41
7 months	64.5	65.54	64.0	64.69
8 months	66.6	66.73	64.5	65.86
9 months	67.8	67.84	68.0	66.96
10 months	68.7	68.89	67.5	67.99
11 months	69.8	69.89	68.8	68.98
12 months	72.0	70.85	69.6	69.92
13 months	69.8	71.78	72.0	70.82
14 months	75.3	72.69	73.4	71.70
15 months	75.5	73.56	73.1	72.55
16 months	75.5	74.42	75.2	73.38
17 months	74.9	75.25	76.0	74.19
18 months	76.0	76.08	73.7	74.99
19 months	77.0	76.88	74.4	75.76
20 months	74.9	77.67	79.0	76.53
21 months	75.5	78.46	77.6	77.28
22 months	78.4	79.22	75.6	78.02
23 months	80.6	79.98	78.4	78.75
24 months	84.0	80.74	78.3	79.47
25 months	} 80.4	{ 81.48	} 81.1	{ 80.18
26 months		82.21		80.88
27 months		82.94		81.58
28 months		83.66		82.27
29 months	} 85.1	{ 84.38	} 84.0	{ 82.95
30 months		85.09		83.63
31 months		85.79		84.30
32 months	} 86.9	{ 86.49	} 84.0	{ 84.96
33 months		87.19		85.63

Equations of curves used in smoothing:
Boys, $y = 52.429051 + 0.548181x + 10.976648$ log. x.
Girls, $y = 51.434797 + 0.507865x + 11.478762$ log. x.
x representing age in months, y representing height in centimeters.

[1] Age is given as of nearest month; that is, "1 month" is from 16 days to 1 month and 15 days, inclusive. Note that from 26 months onward each observed average includes a 3-month interval.

TABLE A4.—*Weight and age: boys 1 to 33 months of age examined in Puerto Rico*

Age [1] at examination	Boys 1 to 33 months of age														
	Total	Weight (kilograms) reported [2]													Weight not reported
		Total reported	3	4	5	6	7	8	9	10	11	12	13	14	
Total	307	305	5	16	24	30	55	49	48	33	26	9	7	3	2
Age reported	295	293	5	16	23	28	53	47	46	32	26	9	6	2	2
1 month	9	9	2	5	2										
2 months	14	11		2	7	2									
3 months	16	16	1		7	4	1								
4 months	19	19		1	3	5	5	4	1						
5 months	18	18		2	1	4	9	1	1						
6 months	16	16	1	2		3	7	1	2						
7 months	13	13		1		1	4	3	1						
8 months	15	16	1	1		2	6	1	3	2					1
9 months	13	13			1	1	4	5		1					
10 months	15	15			1		5	6	2		1				
11 months	17	17		1	1		2	9	3	1					
12 months	12	12				1		4	5	1	1				
13 months	9	9				1	3	3	1		1				
14 months	8	8						2	4		1		1		
15 months	8	8					1	1	1	2	3				
16 months	11	11					1	1	3	3	3				
17 months	12	12						1	6	5					
18 months	6	6						1	3	1	1				
19 months	10	10				1			4	3	1	1			
20 months	7	7						1		2	2	2			
21 months	4	4					1				3				
22 months	5	5							1	2	2				
23 months	7	7						1		3	2	1			
24 months	4	4							2		2				
25 to 27 months	14	14					1	2	1	2	1	4	1	2	
28 to 30 months	7	7									3	3			
31 to 33 months	7	6									1	2		3	1
Age not reported	12	12			1	2	2	2	2	1				1	1	

[1] Age is given as of nearest month: that is, "1 month" is from 16 days to 1 month and 15 days, inclusive, and so on.
[2] Weight is to nearest kilogram; that is, "3 kilograms" is from 2.50 to 3.49 kilograms, inclusive, and so on.

TABLE A5.—*Weight and age; girls 1 to 33 months of age examined in Puerto Rico*

Age [1] at examination	Girls 1 to 33 months of age															
	Total	Weight (kilograms) reported [2]														Weight not reported
		Total reported	2	3	4	5	6	7	8	9	10	11	12	13	14	
Total	274	272	1	2	21	17	42	45	36	38	40	19	6	4	1	2
Age reported	266	264	1	2	21	17	41	43	36	36	37	19	6	4	1	2
1 month	8	8			7	1										
2 months	17	17	1		8	4	4									
3 months	11	11				4	7									
4 months	12	12				3	5	3	1							
5 months	18	18			2	2	10	4								
6 months	15	15			4	1	2	6	2							
7 months	12	12		1			2	6	2	1						
8 months	13	13		1		1	4	3	2	2						
9 months	7	7				1		1	5							
10 months	11	11					2	4	3	1	1					
11 months	10	9					2	4		3						1
12 months	9	9						4	2	2	1					
13 months	13	13					1	1	6	4	1					
14 months	7	7						2			3	2				
15 months	13	13						1	4	2	6					
16 months	5	5								1	4					
17 months	5	5							2	2	1					
18 months	7	7						1	1	1	4					
19 months	5	5						1		3	1					
20 months	4	4								2	1	1				
21 months	9	9							1	2	4	1				
22 months	5	5					1		2		1	1				
23 months	9	9							2	1	3	1	1	1		
24 months	7	6					1		1	2		2				1
25 to 27 months	24	24						1	1	7	3	5	4	3		
28 to 30 months	5	5									1	3	1			
31 to 33 months	5	5						1		1	2				1	
Age not reported	8	8					1	2		2	3					

[1] Age is given as of nearest month; that is, "1 month" is from 16 days to 1 month and 15 days, inclusive, and so on.

[2] Weight is to nearest kilogram; that is, "3 kilograms" is from 2.50 to 3.49 kilograms, inclusive, and so on.

TABLE A6.—*Average weight at each month of age; boys and girls 1 to 33 months of age examined in Puerto Rico*

| Age [1] at examination | Average weight (kilograms) | | | |
| | Boys | | Girls | |
	Observed	Smoothed	Observed	Smoothed
1 month	4.0	4.08	4.1	3.79
2 months	5.0	5.01	4.6	4.81
3 months	5.6	5.69	5.6	5.44
4 months	6.6	6.06	6.2	5.91
5 months	6.5	6.44	5.9	6.30
6 months	6.5	6.77	6.1	6.62
7 months	6.8	7.07	6.8	6.91
8 months	7.3	7.34	6.7	7.18
9 months	7.2	7.59	7.4	7.42
10 months	7.8	7.83	7.5	7.64
11 months	7.8	8.06	7.4	7.85
12 months	8.7	8.28	8.0	8.05
13 months	7.9	8.49	8.2	8.24
14 months	9.5	8.69	9.4	8.42
15 months	9.6	8.89	9.0	8.59
16 months	9.5	9.08	9.8	8.76
17 months	9.3	9.27	9.8	8.92
18 months	9.3	9.46	9.1	9.08
19 months	9.5	9.64	8.8	9.24
20 months	9.7	9.81	9.8	9.39
21 months	9.3	9.99	9.3	9.53
22 months	10.2	10.16	8.6	9.68
23 months	10.3	10.33	10.1	9.82
24 months	10.0	10.49	9.0	9.96
25 months		10.66		10.09
26 months	10.9	10.82	10.4	10.23
27 months		10.98		10.36
28 months		11.14		10.49
29 months	11.7	11.30	11.0	10.62
30 months		11.45		10.75
31 months		11.61		10.87
32 months	11.8	11.76	10.8	10.99
33 months		11.91		11.12

Equations of curves used in smoothing:
Boys, $y = 3.966361 + 0.116496x + 2.701817 \log. x$.
Girls, $y = 3.713483 + 0.080924x + 3.116864 \log. x$.
x representing age in months, y representing weight in kilograms.

[1] Age is given as of nearest month; that is, "1 month" is from 16 days to 1 month 15 days, inclusive. Note that from 26 months onward each observed average includes a 3-month interval.

TABLE A7.—*Weight for height of boys 1 to 33 months of age examined in Puerto Rico*

Height (centimeters)	Total	Boys 1 to 33 months of age														
		Weight (kilograms) reported														Weight not reported
		Total re-ported	3	4	5	6	7	8	9	10	11	12	13	14	
Total	307	305	5	16	24	30	55	49	48	33	26	9	7	3	2
Height reported	304	302	4	16	24	30	55	49	46	33	26	9	7	3	2
47, under 49	1	1	1												
49, under 51															
51, under 53	2	2		2											
53, under 55	11	11	1	4	6										
55, under 57	10	10	1		9										
57, under 59	7	7		5	2										
59, under 61	15	15	1	3	2	6	3								
61, under 63	26	26			4	13	7	2							
63, under 65	24	24		2	1	5	14	1	1						
65, under 67	20	19				4	11	4							1
67, under 69	28	28				2	10	11	5						
69, under 71	28	28					6	12	7	3					
71, under 73	27	27					1	14	7	4	1				
73, under 75	21	21					1	2	11	4	3				
75, under 77	23	23					1	2	8	10	1		1		
77, under 79	15	15					1	1	3	8	2				
79, under 81	14	14							2	2	8	2			
81, under 83	11	11							1	1	6	2	1		
83, under 85	7	7								1	4	1	1		
85, under 87	4	4							1			2		1	
87, under 89	5	5									1	1	2	1	
89, under 91	3	3										1	1	1	
91, under 93															
93, under 95	2	1											1		1
Height not reported	3	3	1						2						

TABLE A8.— *Weight for height: girls 1 to 33 months of age examined in Puerto Rico*

Height (centimeters)	Total	Girls 1 to 33 months of age														
		Weight (kilograms) reported														Weight not reported
		Total re-ported	2	3	4	5	6	7	8	9	10	11	12	13	14	
Total	274	272	1	2	21	17	42	45	36	38	40	19	6	4	1	2
Height reported	272	270	1	2	20	17	41	45	36	38	40	19	6	4	1	2
45, under 47	1	1	1													
47, under 49	1	1			1											
49, under 51	2	2			2											
51, under 53	1	1			1											
53, under 55	13	13		1	10	2										
55, under 57	9	9		1	3	3	2									
57, under 59	13	13			2	6	5									
59, under 61	17	17				2	13	2								
61, under 63	20	20			1	3	9	7								
63, under 65	14	14				1	7	5	1							
65, under 67	26	26					1	17	6	1						
67, under 69	13	13					1	5	6	1						
69, under 71	18	18					1	5	9	2	1					
71, under 73	19	19						1	4	11	3					
73, under 75	25	24					1	2	5	8	7	1				1
75, under 77	23	23						1	2	7	12	1				
77, under 79	17	17							3	6	7	1				
79, under 81	10	10									7	3				
81, under 83	14	14								2	2	7	2	1		
83, under 85	3	3										2	1			
85, under 87	9	8									1	3	2	2		1
87, under 89	2	2											1	1		
89, under 91	1	1										1				
91, under 93	1	1													1	
Height not reported	2	2			1		1									

TABLE A9. — *Average weight for height: Puerto Rican boys and girls*

Average height (centimeters)	Average weight (kilograms)				Average height (centimeters)	Average weight (kilograms)			
	Boys		Girls			Boys		Girls	
	Observed	Smoothed	Observed	Smoothed		Observed	Smoothed	Observed	Smoothed
46			2.0	2.65	72	8.6	8.53	8.8	8.47
48	3.0	2.89	4.0	3.10	74	9.3	9.00	8.9	8.92
50		3.36	4.0	3.54	76	9.5	9.47	9.4	9.36
52	4.0	3.83	4.0	3.99	78	9.6	9.94	9.4	9.81
54	4.5	4.30	4.1	4.44	80	10.7	10.41	10.3	10.26
56	4.8	4.77	4.7	4.89	82	11.1	10.88	10.9	10.71
58	4.3	5.24	5.2	5.33	84	11.3	11.35	11.3	11.15
60	5.5	5.71	6.0	5.78	86	11.8	11.82	11.6	11.60
62	6.3	6.18	6.1	6.23	88	12.6	12.29	12.5	12.05
64	6.6	6.65	6.4	6.68	90	13.0	12.76	11.0	12.50
66	7.0	7.12	7.2	7.12	92		13.23	14.0	12.94
68	7.7	7.59	7.5	7.57	94	13.0	13.71		
70	8.3	8.06	7.8	8.02					

Equations of curves used in smoothing:
Boys, $y = 2.415280 + 0.235207x$.
Girls, $y = 2.199633 + 0.223848x$.
x representing centimeters of height above 46; y representing weight in kilograms.

TABLE A10. — *Head circumference and age: boys 1 to 33 months of age examined in Puerto Rico*

Age at examination	Total	\[Head circumference (centimeters) [2]\]																	
		34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Total	367	1	1	3	6	9	10	23	17	28	37	25	26	44	41	23	11	1	1
Age reported	295	1	1	3	6	9	10	22	16	27	35	24	24	43	40	21	11	1	1
1 month	5	1	1	2	2	2		1											
2 months	31			1	1	5	2	3	1										
3 months	26				2	2	2	6	1	3									
4 months	19					1		5	5	2	3								
5 months	18						1	4	3	6	3	1							
6 months	16				1		1	2	2	3	5		1			1			
7 months	15							4		4	5	3							
8 months	17					1				3	7	2	3		1				
9 months	13								1	1	2	5	1	2					
10 months	15									2	6	2	1	3	1				
11 months	17						1		2	1	3	3	4	2	1				
12 months	12									1	1	1	2	1	1				
13 months	9									1	1	3	1	2	1				
14 months	8											1	1	2	2	2			
15 months	8												1	4	3				
16 months	11												1	2	3	4			
17 months	12												1	5	5	1			
18 months	6											1	1	2		2			
19 months	10								1					1	6	1	1		
20 months	7														4	1	2		
21 months	4													1	2	1			
22 months	5													1	3	1			
23 months	7													1	3	1	1		
24 months	4													1	1	2			
25 to 27 months	14											1		2	4	3	3		1
28 to 30 months	7													2	2	2	1		
31 to 33 months	7														1	1	4	1	
Age not reported	12							1	1	1	2	1	2	1	1	2			

[1] Age is given as of nearest month; that is, "1 month" is from 16 days to 1 month and 15 days, inclusive, and so on.
[2] Head circumference is given as of nearest centimeter; that is, "34 centimeters" is from 33.50 to 34.49 centimeters, inclusive, and so on.

TABLE A11.— *Head circumference and age: girls 1 to 33 months of age examined in Puerto Rico*

Age [1] at examination	Girls 1 to 33 months of age																
	Total	Head circumference (centimeters) [2]															
		34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Total	274	2	2	8	10	10	11	18	15	24	25	45	37	32	17	9	9
Age reported	266	2	2	8	10	10	11	18	15	23	25	41	35	31	17	9	9
1 month	8	1	2	1	1												
2 months	17	1	---	5	4	3	1	3									
3 months	11			2	2	2	2	4	1								
4 months	12				2	2	3	3	3	1		1					
5 months	18					2	3	3	5	3	1		1				
6 months	15					1	3	3	2	5	1						
7 months	12			1				2	2	3	2	1	1				
8 months	13			1					1	5	3	2	1				
9 months	7									1	1	5					
10 months	11									1	4	4	1	1			
11 months	10								1	1	3	3		2			
12 months	9										3	4	2	2			
13 months	13										4	5	2	2			
14 months	7									1			4		1		1
15 months	13									1		5	4	3			
16 months	5											2	1	2			
17 months	5											1	2	2			
18 months	7										1		3	3			
19 months	5										1		1	3			
20 months	4											1		2			1
21 months	9											2	2	2	3		
22 months	5									1			2	1		1	
23 months	9										1	1		2	1	1	3
24 months	7											2	1		4		
25 to 27 months	24											1	6	3	5	6	3
28 to 30 months	5												1	1	2		1
31 to 33 months	5											1		2	1	1	
Age not reported	8									1		4	2	1			

[1] Age is given as of nearest month; that is, "1 month" is from 16 days to 1 month and 15 days, inclusive, and so on.
[2] Head circumference is given as of nearest centimeter; that is, "34 centimeters" is from 33.50 to 34.49 centimeters, inclusive, and so on.

TABLE A12.—*Average head circumference at each month of age; boys and girls 1 to 33 months of age examined in Puerto Rico*

Age [1] at examination	Average head circumference (centimeters)			
	Boys		Girls	
	Observed	Smoothed	Observed	Smoothed
1 month	36.8	36.25	36.0	35.33
2 months	38.5	38.62	37.4	37.77
3 months	39.7	40.00	39.0	39.19
4 months	40.7	40.99	40.3	40.19
5 months	41.5	41.76	40.7	40.96
6 months	42.0	42.38	40.7	41.59
7 months	42.7	42.91	41.6	42.12
8 months	43.3	43.38	42.2	42.57
9 months	43.9	43.78	43.6	42.97
10 months	44.0	44.15	43.7	43.33
11 months	43.7	44.48	43.6	43.64
12 months	45.5	44.78	43.9	43.93
13 months	44.6	45.06	44.2	44.20
14 months	46.4	45.32	45.4	44.44
15 months	46.3	45.56	44.6	44.67
16 months	46.7	45.79	45.0	44.88
17 months	46.5	46.00	45.2	45.07
18 months	46.2	46.20	45.1	45.26
19 months	46.5	46.39	45.2	45.43
20 months	46.7	46.58	46.3	45.59
21 months	46.0	46.75	45.7	45.75
22 months	46.8	46.91	45.2	45.89
23 months	47.0	47.07	46.8	46.03
24 months	46.3	47.22	45.9	46.16
25 months		47.37		46.29
26 months	47.6	47.51	46.8	46.41
27 months		47.64		46.52
28 months		47.77		46.63
29 months	47.4	47.90	46.8	46.73
30 months		48.02		46.84
31 months		48.14		46.93
32 months	48.7	48.26	46.2	47.03
33 months		48.37		47.11

Equations of curves used in smoothing:
Boys, $y = 36.241792 + 0.006690x + 7.839603 \log. x$.
Girls, $y = 35.346584 - 0.019527x + 8.173817 \log. x$.
x representing age in months; y representing head circumference in centimeters.

[1] Age is given as of nearest month; that is, "1 month" is from 16 days to 1 month and 15 days, inclusive. Note that from 26 months onward each observed average includes a 3-month interval.

Appendix B.—SKELETAL SIGNS OF RICKETS

TABLE B1.—*Clinical diagnosis of rickets in relation to number of skeletal signs usually considered evidence of rickets; children examined in Puerto Rico*

Number of skeletal signs	Children, examined							
	Total		Clinical diagnosis of rickets					
			No rickets		Questionable diagnosis		Rickets	
	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution
Total	584	100	400	100	134	100	50	100
None	238	41	236	59	2	1		
1	208	36	136	34	69	51	3	6
2	97	17	24	6	51	38	22	44
3	30	5	4	1	11	8	15	30
4	9	2			1	1	8	16
6	2	(1)					2	4

[1] Less than 1 per cent.

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TABLE B2.--*Clinical diagnosis of rickets in relation to combinations of skeletal signs usually considered evidence of rickets: children examined in Puerto Rico*

Skeletal signs	T	No rickets	Questionable diagnosis	Rickets Total	Slight	Moderate	Marked
Total	584	400	134	50	46	3	1
None	238	236	2				
One skeletal sign only	208	136	69	3	3		
Costochondral junctions	25	2	23				
Epiphyses	15	4	11				
Bowlegs	87	72	12	3	3		
Knock-knees	37	32	5				
Harrison's groove	9	2	7				
Parietal or frontal bosses moderately enlarged	14	7	7				
Craniotabes	3	1	2				
Asymmetry of head	18	16	2				
Two skeletal signs	97	24	51	22	21	1	
Costochondral junctions and epiphyses	5		1	4	4		
Costochondral junctions and bowlegs	17	3	9	5	5		
Costochondral junctions and knock-knees	7	2	5				
Costochondral junctions and Harrison's groove	1		1				
Costochondral junctions and parietal or frontal bosses moderately enlarged	3	1	1	1	1		
Costochondral junctions and craniotabes	1			1	1		
Costochondral junctions and asymmetry of head	2		1	1	1		
Epiphyses and bowlegs	17	1	13	3	3		
Epiphyses and knock-knees	1	1					
Epiphyses and Harrison's groove	1		1				
Epiphyses and asymmetry of head	1	1					
Bowlegs and knock-knees	13	10	3				
Bowlegs and Harrison's groove	5		3	2	2		
Bowlegs and parietal or frontal bosses moderately enlarged	9	1	8				
Knock-knees and Harrison's groove	5	1	1	3	3		
Knock-knees and parietal or frontal bosses moderately enlarged	5	3	2				
Harrison's groove and pigeon-breast	1			1		1	
Asymmetry of head and parietal or frontal bosses moderately enlarged	2		2				
Parietal and frontal bosses moderately enlarged	1			1	1		
Three skeletal signs	30	4	11	15	15		
Costochondral junctions, epiphyses, and parietal or frontal bosses moderately enlarged	1			1	1		
Costochondral junctions, epiphyses, and bowlegs	6		3	3	3		
Costochondral junctions, epiphyses, and knock-knees	2			2	2		
Costochondral junctions, bowlegs, and asymmetry of head	2	1	1				
Costochondral junctions, bowlegs, and parietal or frontal bosses moderately enlarged	1		1				
Costochondral junctions, bowlegs, and Harrison's groove	3			3	3		
Costochondral junctions, bowlegs, and knock-knees	3		2	1	1		

TABLE B2.—*Clinical diagnosis of rickets in relation to combinations of skeletal signs usually considered evidence of rickets; children examined in Puerto Rico.*—Con.

Skeletal signs	Children examined						
	Total	Clinical diagnosis of rickets					
		No rickets	Questionable diagnosis	Rickets			
				Total	Slight	Moderate	Marked
Three skeletal signs—Continued							
Costochondral junctions, parietal or frontal bosses moderately enlarged, and asymmetry of head	2	-------	1	1	1	-------	-------
Costochondral junctions, Harrison's groove, and asymmetry of head	1	-------	-------	1	1	-------	-------
Costochondral junctions, Harrison's groove, and knock-knees	1	-------	1	-------	-------	-------	-------
Epiphyses, bowlegs, and asymmetry of head	1	1	-------	-------	-------	-------	-------
Epiphyses, bowlegs, and knock-knees	1	1	-------	-------	-------	-------	-------
Bowlegs, knock-knees, and parietal or frontal bosses moderately enlarged	2	-------	1	1	1	-------	-------
Bowlegs, knock-knees, and Harrison's groove	2	-------	-------	2	2	-------	-------
Knock-knees, parietal or frontal bosses moderately enlarged, and asymmetry of head	1	1	-------	-------	-------	-------	-------
Asymmetry of head and parietal and frontal bosses moderately enlarged	1	-------	1	-------	-------	-------	-------
Four skeletal signs	9	-------	1	8	7	1	-------
Costochondral junctions, epiphyses, bowlegs, and knock-knees	1	-------	-------	1	1	-------	-------
Costochondral junctions, epiphyses, bowlegs, and parietal or frontal bosses moderately enlarged	1	-------	-------	1	1	-------	-------
Costochondral junctions, epiphyses, bowlegs, and Harrison's groove	2	-------	-------	2	1	1	-------
Costochondral junctions, epiphyses, knock-knees, and parietal or frontal bosses moderately enlarged	1	-------	-------	1	1	-------	-------
Costochondral junctions, epiphyses, knock-knees, and Harrison's groove	1	-------	-------	1	1	-------	-------
Costochondral junctions, bowlegs, Harrison's groove, and parietal or frontal bosses moderately enlarged	1	-------	-------	1	1	-------	-------
Epiphyses, bowlegs, Harrison's groove, and knock-knees	1	-------	-------	1	1	-------	-------
Epiphyses, bowlegs, Harrison's groove, and asymmetry of head	1	-------	1	-------	-------	-------	-------
Six skeletal signs	2	-------	-------	2	-------	1	1
Parietal and frontal bosses moderately enlarged, costochondral junctions, epiphyses, Harrison's groove, and craniotabes	1	-------	-------	1	-------	-------	1
Parietal and frontal bosses moderately enlarged, costochondral junctions, Harrison's groove, knock-knees, and asymmetry of head	1	-------	-------	1	-------	1	-------

Appendix C.—TECHNIQUE OF ROENTGEN-RAY EXAMINATION

The technique of the roentgen-ray examination of the bones of the forearm followed in every detail that used in New Haven. The roentgenograms were taken on 8 by 10 inch superspeed films, placed in flat film holders without screens. It had been found that the detail of the bone structure was partly lost if screens were used, and though the length of exposure was necessarily longer without screens, the resulting roentgenogram was very much more satisfactory. In order to keep the time of exposure as short as possible, filters were not used. A fine-focus 30-milliampere radiator tube was used with a target-film distance of 20 inches. The target-film distance was kept unchanged throughout the examinations. A current of 40 milliamperes with a spark gap of 3½ inches was used. The time of exposure varied from one-fourth to three-fourths of a second, depending on the thickness of a child's wrist, the smallest wrists requiring a bare one-fourth second and the largest, those of well-nourished children of 18 months or over, three-fourths of a second. Experience in New Haven had shown that it was of utmost importance that the child's arm should be held absolutely still during the exposure. If any movement took place, even the very slightest, the detail of the bone structure was blurred and the interpretation of the film made more difficult or impossible. To avoid this as far as possible, one of the physicians held each child for the roentgen-ray examination. The hand was placed palm up with the arm extending at right angles to the body and in extreme external rotation, so that the two bones of the forearm would lie parallel to each other and not crossed. As often as possible the roentgenograms were developed before the child left the clinic, and, if they were not satisfactory, further films were taken. In this way roentgenograms were obtained which were on the whole satisfactory for diagnosis.

Further experience has shown, however, that the detail of the bone structure will be clearer and the chance lessened that movement will spoil the roentgenograms if the time of exposure is shortened to one-tenth of a second, if a current of 100 milliamperes and a kilovolt peak of 75 are used, and if the target-film distance is lengthened to 30 inches. If the exposure is accurately timed to one-tenth of a second and the kilovolt peak is 75 or less, 100 milliamperes may be passed through a 30-milliampere radiator tube without damage to the tube.

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Appendix D.—GRADING OF CHILDREN'S DIETS

Appendix Tables D-1 to D-6 show the grades given to the children's diets for each of the four 3-month periods of the first year and for the whole second and third years and show also the different combinations of milk and solid foods that fall within the range of each grade. The number of children whose diets fell in each grade is shown and in addition the number of children in each grade for whom the period was complete and the number for whom it was incomplete. (See p. 89.)

It should be remembered in studying these tables that together they represent diet histories for 554 children (2 diet histories were not reported). The diet histories of 293 of these children were reported for all four 3-month periods of the first year; of 367, for three periods; of 469, for two periods; and for 554, for 1 period. More than half the children appear, therefore, in all four tables representing the first year.

It will be seen in each table that the number of children that had not yet completed the diet period (those whose ages at the time of the interview still fell within the age range of the period) is comparatively small and that the differences in the distribution of diet grades of the two groups are insufficient to be considered significant. The total number of diets in each grade, therefore, has been used in the comparisons, regardless of whether they are for complete or incomplete periods.

TABLE D1.—*Diet grade and type of feeding of children during first 3-month period (birth to 3 months); children in families visited in Puerto Rico*

Diet grade	Type of feeding		Children in families visited						
			Total		Age at date of home visit				Not re-ported
					Under 4 months		4 months and over		
	Breast milk	Cow's milk (average amount daily)	Num-ber	Per cent distri-bution	Num-ber	Per cent distri-bution	Num-ber	Per cent distri-bution	
Total			556		70		473		13
Grade reported			554	100	70	100	472	100	12
Very good	Entirely	None	385	69	54	77	322	68	9
Good			140	25	14	20	124	26	2
	Mainly	1 cup	110	20	12	17	96	20	2
	Small amount	1 pint	30	5	2	3	28	6	
Fair	None	do	9	2			9	2	
Poor	None	1 cup	20	4	2	3	17	4	1
Grade not reported			2				1		1

TABLE D2.—*Diet grade and type of feeding of children during second 3-month period (fourth to sixth month): children 4 months of age and over in families visited in Puerto Rico*

Diet grade	Type of feeding			Children 4 months of age and over in families visited					
	Milk feeding		Some form of solid food[1]	Total		Age at date of home visit			
						4 to 6 months		7 months and over	
	Breast milk	Cow's milk (average amount daily)		Number	Percent distribution	Number	Percent distribution	Number	Percent distribution
Total				573		100		373	
Grade reported				469	100	98	100	371	100
Very good				34	7	11	11	23	6
	Entirely	None	+	14	3	7	7	7	2
	Mainly	1 cup	+	20	4	4	4	16	4
Good				300	64	68	69	232	63
	Entirely	None	0	212	45	37	38	175	47
	Mainly	1 cup	0	61	13	23	23	38	0
	Small amount	1 pint	+	21	4	6	6	15	4
	None	More than 1 pint.	+	6	1	2	2	4	1
Fair				78	17	13	13	65	18
	Small amount	1 pint	0	33	7	4	4	29	8
	None	More than 1 pint.	0	26	6	5	5	21	6
	None	1 pint	+	19	4	4	4	15	4
Poor	None	1 pint	0	27	6	4	4	23	6
Very poor				30	6	2	2	28	8
	None	1 cup	0	9	2	1	1	8	2
	None	do	+	21	4	1	1	20	5
Grade not reported				4		2		2	

[1] "+" indicates that some solid food was given; "0" that no solid food was given. The kind of solid food was not considered.

TABLE D3.—*Diet grade and type of feeding of children during third 3-month period (seventh to ninth month); children 7 months of age and over in families visited in Puerto Rico*

Diet grade	Type of feeding			Children 7 months of age and over in families visited					
	Milk feeding		Some form of solid food [1]	Total		Age at date of home visit			
						7 to 9 months		10 months and over	
	Breast milk	Cow's milk (average amount daily)		Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution
Total				373		74		299	
Grade reported				367	100	73	100	294	100
Very good				49	13	5	7	44	15
	Entirely	None	+	22	6	1	1	21	7
	Mainly	1 cup	+	27	7	4	5	23	8
Good				58	16	13	18	45	15
	Small amount	1 pint	+	30	8	6	8	24	8
	None	More than 1 pint.	+	28	8	7	10	21	7
Fair				214	58	46	63	168	57
	Entirely	None	0	105	29	21	29	84	29
	Mainly	1 cup	0	30	8	6	8	24	8
	Small amount	1 pint	0	23	6	6	8	17	6
	None	More than 1 pint.	0	30	8	9	12	21	7
	None	1 pint	+	26	7	4	5	22	7
Poor	None	1 pint	0	21	6	5	7	16	5
Very poor				25	7	4	5	21	7
	None	1 cup	+	11	3	1	1	10	3
	None	do	0	14	4	3	4	11	4
Grade not reported				6		1		5	

[1] "+" indicates that some form of solid food was given; "0" that no solid food was given. The kind of solid food was not considered.

TABLE D4.—*Diet grade and type of feeding of children during fourth 3-month period (tenth to twelfth month); children 10 months of age and over in families visited in Puerto Rico*

Diet grade	Type of feeding — Milk feeding — Breast milk	Cow's milk (average amount daily)	Solid food [1]	Children 10 months — Total Number	Per cent distribution	10 to 12 months Number	Per cent distribution	13 months and over Number	Per cent distribution
Total				299	...	66	.....	233	.....
Grade reported				293	100	66	100	227	100
Very good				12	4	2	3	10	4
	None	More than 1 pint	Satisfactory	7	2	1	2	6	3
	Small amount	1 pint	....do	5	2	1	2	4	2
Good				2	1	.....	.....	2	1
	Small amount	1 pint	Borderline	1	(2)	.....	.....	1	(2)
	Mainly	1 cup	Satisfactory	1	(2)	.....	.....	1	(2)
Fair				7	2	1	2	6	3
	None	1 pint	Borderline	3	1	1	2	2	1
	Mainly	do	..do	2	1	.....	.....	2	1
	Entirely	None	..do	2	1	.....	.....	2	1
Poor				200	68	46	70	154	68
	None	More than 1 pint	Unsatisfactory	29	10	9	14	20	9
	None	do	None	16	5	.....	.....	16	7
	Small amount	1 pint	Unsatisfactory	24	8	9	14	15	7
	Do	do	None	17	6	6	11	10	4
	Mainly	1 cup	Unsatisfactory	22	8	9	14	13	6
	Do	do	None	14	5	2	3	12	5
	Entirely	None	Unsatisfactory	28	10	4	6	24	11
	Do	None	None	50	17	6	9	44	19
Very poor				72	25	17	26	55	24
	None	1 pint	Unsatisfactory	32	11	10	15	22	10
	None	do	None	15	5	3	5	12	5
	None	1 cup	Unsatisfactory	16	5	2	3	14	6
	None	do	None	9	3	2	3	7	3
Grade not reported				6	.....	.....	.....	6	.....

[1] For method of grading solid food see p. 91.
[2] Less than 1 per cent.

TABLE D5.— *Diet grade and type of feeding of children during second year; children 13 months of age and over in families visited in Puerto Rico*

Diet grade	Type of feeding			Children 13 months of age and over in families visited					
	Milk feeding		Solid food [1]	Total		Age at date of home visit			
						13 to 24 months		25 months and over	
	Breast milk	Cow's milk (average amount daily)		Number	Per cent distribution	Number	Per cent distribution	Number	Per cent distribution
Total				233		176		57	
Grade reported				203	100	147	100	56	100
Very good	None	1½ to 2 pints	Very satisfactory	2	1	1	1	1	2
Good				6	3	2	1	4	7
	None	1½ to 2 pints	Satisfactory	1	(²)			1	2
	None	1 pint	do	5	2	2	1	3	5
Fair				23	11	21	14	2	4
	None	1½ to 2 pints	Borderline	7	3	7	5		
	None	1 pint	do	9	4	7	5	2	4
	Small amount	do	do	4	2	4	3		
	Mainly	1 cup	Satisfactory	3	1	3	2		
Poor				71	35	48	33	23	41
	None	1½ to 2 pints	Unsatisfactory	10	5	8	5	2	4
	None	1 pint	do	28	14	18	12	10	18
	None	1 cup	Borderline	4	2	3	2	1	2
	Small amount	1 pint	Unsatisfactory	26	13	17	12	9	16
	Mainly	1 cup	Borderline	2	1	2	1		
	Entirely	None	do	1	(²)			1	2
Very poor				101	50	75	51	26	46
	None	1½ to 2 pints	Very unsatisfactory	2	1	1	1	1	2
	None	do	None	3	1	2	1	1	2
	None	1 pint	Very unsatisfactory	3	1	2	1	1	2
	None	1 cup	Unsatisfactory or very unsatisfactory	42	21	28	19	14	25
	None	do	None	3	1	3	2		
	Small amount	1 pint	Very unsatisfactory	3	1	2	1	1	2
	Mainly	1 cup	Unsatisfactory or very unsatisfactory	32	16	27	18	5	9
	Do	do	None	1	(²)			1	2
	Entirely		Unsatisfactory or very unsatisfactory	9	4	7	5	2	4
	Do		None	3	1	3	2		4
Grade not reported				³ 30		³ 29		1	

[1] For method of grading solid food, see p. 92
[2] Less than 1 per cent.
[3] Includes 26 children for whom diet grade was not reported as they had lived only one month into this period.

TABLE D6.—*Diet grade and type of feeding of children during third year; children 25 months of age and over in families visited in Puerto Rico*

| Diet grade | Type of feeding | | | Children 25 months of age and over at date of home visit |
| | Milk feeding | | Solid food [1] | |
	Breast milk	Cow's milk (average amount daily)		
Total				57
Grade reported				40
Very good	None	1½ to 2 pints	Very satisfactory	1
Good	None	1 pint	Satisfactory	2
Fair				8
	None	1½ to 2 pints	Borderline	3
	None	1 pint	do	2
	None	1 cup	Satisfactory	3
Poor				9
	None	1½ to 2 pints	Unsatisfactory	1
	None	1 pint	do	6
	None	1 cup	Borderline	2
Very poor				20
	None	1 cup	Unsatisfactory or very unsatisfactory.	18
	Mainly	do	do	2
Grade not reported				[2] 17

[1] For method of grading solid food, see p. 92.
[2] Includes 16 children for whom grade was not reported as they had lived only 1 month into this period.

Appendix E.—CASE HISTORIES OF CHILDREN SHOWING ROENTGEN-RAY EVIDENCE OF RICKETS

Because of the rarity of rickets in Puerto Rico the case histories of the five children showing roentgen-ray evidence of the disease are given in detail.

Case 1.—S. M., male, age, 6 months, 16 days. Full term, fourth pregnancy, normal birth. Three older children were dead; the first at 10 days, of hemorrhage, the second, at 9 months, of "meningitis," the third, at 3 months, of colic.

S. M. was born in a cellar of one of the large stone tenements of San Juan, in a 1-room apartment that had no windows opening to the outside and was lighted only by electricity. He had been sickly from birth, was breast fed only a few days, and was never taken out of the cellar for fear he would "catch cold." Two weeks before examination he was moved to a new and lighter tenement. Until this time he had literally never been exposed to daylight; nor, because he was artificially fed, had he received the benefit of any antirachitic vitamin through breast milk. His diet consisted of a cow's milk formula, without additional food of any sort. No cod-liver oil had ever been given. There was a history of frequent attacks of bronchitis, and, for the past three or four months, daily convulsions associated with what was thought by the local doctor to be meningitis.

Physical examination showed a fairly well-nourished infant; weight, 7 kilograms; height, 64 centimeters. He was pale, cyanotic, breathing rapidly, and obviously sick. There was no evidence of tanning, and his musculature was flabby and weak. He could not sit up. His head was large and hydrocephalic in type; the anterior fontanelle was full, and measured approximately 7 centimeters in its anteroposterior diameter and 7 centimeters in lateral diameter; the sagittal, coronal, and lambdoidal sutures were open. There was slight craniotabes in the parietal bone just behind and above the left mastoid process. The frontal and parietal bosses were moderately enlarged. Examination of the chest showed moderately enlarged costochondral junctions and a Harrison's groove with accompanying flaring of the costal margins of the ribs. The epiphyses of the long bones at the wrist were moderately enlarged. There was a moderate degree of pot-belly, and an enlarged spleen. The legs showed no rachitic deformities. Chvostek's sign for tetany was not elicited. Examination of the lungs revealed a definite broncho-pneumonia, with signs of consolidation at the right upper lobe. Roentgenogram of the chest corroborated the diagnosis of broncho-pneumonia. The heart was negative.

Roentgenograms of the bones of the forearm showed advanced rickets with a marked degree of osteoporosis accompanying it (fig. 1). The cortex was poorly calcified; the periosteum, faintly visible, was elevated on both radius and ulna. There was no evidence of deposit of calcium in the zone of primary calcification of the lower ends of radius and ulna, and there was a small amount of fraying or fringing of the distal end of both radius and ulna, but the rachitic intermediary zone, sometimes called the rachitic metaphysis, was not defined by lime-salt deposit at its periphery. There was, therefore, essentially no cupping, and only slight spreading of the ends of both bones. The trabeculae toward the end of the shaft were irregularly placed, and, at the extreme end of the shaft, lay at various angles, forming a dense irregular line, such as is commonly seen in severe rickets. The picture was that of the type of rickets described by Wimberger[81] as occurring in inactive children, a type which though very severe, shows comparatively little evidence of cupping and fraying, but marked osteoporosis of the bones. Such a picture occurs when the disease is so severe that there is inability on the part of the organism to reinforce the weakened bone by laying down lime salts in the periphery of the rachitic intermediary zone.

Blood studies were made in the chemical laboratory of the School of Tropical Medicine and showed a calcium content of 7.1 milligrams per cubic centimeter of serum, and a phosphorus content of 4.1 milligrams. A diagnosis of severe active rickets was made from the clinical and roentgen-ray examinations, and of tetany

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[81] Wimberger, Hans: Klinisch-radiolische Diagnostik von Rachitis, Skorbut, und Lues inn Kindesalter- [Clinical and Radiological Diagnosis of Rickets, Scurvy, and Congenital Syphilis in Childhood.] Ergebnisse der inneren Medizin und Kinderheilkunde [Berlin], vol. 28 (1925), pp. 269-288.

from the chemical examination of the blood. Treatment with sun baths was instituted in the Presbyterian Hospital. The diet was kept the same. No cod-liver oil was given. At the end of 18 days healing had begun (fig. 2), as was shown by the deposit of lime salt both in the subperiosteal tissues and in and around the intermediary rachitic zone at both ends of the radius and ulna, and by the increase in the blood calcium to 8.3 milligrams and in the phosphorus to 5.2 milligrams. Three months later advanced healing had taken place (fig. 3).

Case 2.—W. V., male, age 5 months, 12 days. Full term. He was breast fed at night with supplementary feeding of condensed milk and rice water during the day. He was taken out of doors very little, about half an hour daily in the shade. His mother went out of doors very little.

Physical examination: Weight, 6 kilograms; height, 64½ centimeters. The amount of his subcutaneous fat and his muscular development were estimated as fair; the color of his mucous membranes was good; his skin was lightly pigmented, but there was no tanning. The costochondral junctions were slightly enlarged; there was slight bowing of the legs, which was probably not abnormal at his age. A clinical diagnosis of questionable rickets was made on the basis of the slightly enlarged costochondral junctions.

The roentgenogram showed a fairly thick type of bone with a slight degree of osteoporosis. The cortex was poorly calcified and thick, apparently having been laid down in layers, a condition frequently seen at this age when growth is very rapid; the periosteal surface of the shaft was not everywhere well defined; the zones of primary calcification of both radii and ulnae were poorly defined and irregularly calcified, there was slight cupping of both ulnae, and irregular calcification which suggested fringing. A roentgenographic diagnosis of slight rickets was made.

Case 3.—J. L., female, age 5 months 13 days. Full term. Breast fed entirely. Physical examination: Weight, 6.24 kilograms; height, 61 centimeters. A well-nourished, plump infant, with good muscular development and good color of mucous membranes. Her skin was lightly pigmented and was tanned only on the knees. There was no clinical evidence of rickets.

Roentgenographic examination showed a less heavy type of bone than that of the previous case, and one which was fairly well calcified throughout. The cortex was of average thickness. There was definite though slight cupping at the distal ends of both ulnae. The zone of primary calcification was not quite clearly defined nor everywhere complete. There were certain breaks in the contour which suggested very early rickets. The ulna side of the distal end of the radius showed a slight decrease in density; otherwise the distal ends of the radii appeared normal. A roentgenographic diagnosis of very slight rickets was made.

Case 4.—M. S., male, age 2 months 26 days. Full term. Breast fed. Physical examination: Weight, 4.88 kilograms; height, 56 centimeters. A fairly well-nourished infant with good muscular development, pale mucous membranes, lightly pigmented skin, and no tanning. The anterior fontanelle was 4 centimeters long and 5 centimeters wide. There was a moderate degree of craniotabes, which was bilateral. The costochondral junctions were slightly enlarged. A clinical diagnosis of slight rickets was made.

Roentgenographic examination showed bones of average thickness. The shaft was well calcified, with cortex of normal density and thickness. There was slight cupping of the distal ends of both ulnae. The zones of primary calcification of the ulnae showed slight irregularities and what appeared to be breaks in calcification. The distal ends of the radii were also not clearly defined. A roentgenographic diagnosis of very slight rickets was made.

Case 5.—M. G., female, age 25 months. Full term. Born in New York City, where the first 21 months of life were spent, and taken to Puerto Rico 4 months before examination. She was breast fed for 3 months, then given a diet at first of fresh cow's milk and later of condensed milk, supplemented by soup, eggs, potatoes, yautias, cereal, and fruit. No cod-liver oil had ever been given.

Physical examination showed a well-nourished child—weight, 12.02 kilograms; height, 85 centimeters. Her skin and mucous membranes were of good color, and she was tanned on face, neck, arms, and legs. There was very little clinical evidence that would lead to a diagnosis of rickets, slightly enlarged costochondral junctions and slight knock-knees being the only signs present.

The roentgenogram of the bones of the forearm taken on the day of examination showed evidence of old healed rickets. The shafts of the bones were well calcified, there was no osteoporosis, and the cortex was clearly defined and of about average width. The diaphyseal-epiphyseal junctions were well calcified

and clearly defined.   The zones of primary calcification were unbroken.   The trabeculae at the distal ends of both radii and ulnae were regular, well calcified, and clearly visible up to the zone of primary calcification.

In the substance of the spongiosa, about 2 centimeters from the distal end of both the right and left ulnæ, there was an irregular, rather poorly defined zone of increased density, approximately 3 millimeters in width, made up of irregularly and rather closely placed trabeculae.   There was a slight thickening of the inner surface of the cortex in this region and just above, with some irregular narrowing of the medullary space.   In the radii, also, similar zones, though even less well defined, could be seen at approximately 2 centimeters from the distal ends of the bones.   In both radii at the region of this zone there was a slight bulging of the shaft.   The zones of increased density probably represent an old healed rachitic process, which was of moderate severity when active.   The amount of bone that has grown since the zone formed would indicate that the rachitic process had probably occurred in the winter and healed in the summer previous to the examination.

Though this case is included in Table 10 it can not legitimately be counted as a case of rickets developing in the Tropics.